A SYSTEMS APPROACH TO ASSESS THE REDEVELOPMENT OPTIONS FOR URBAN BROWNFIELD SITES

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Abstract

The problem addressed is: How can an appropriate redevelopment option for an urban brownfield site be determined?

A systems-based approach, Brownfield REMIT/RESPONSE (BRR), to assess the impact of brownfield redevelopment on the surrounding urban area has been developed. This utilises REMIT/RESPONSE combined with urban theory to develop a dynamic model of the generic impact of brownfield redevelopment that when combined with site-specific information can be used to identify and compare the impact of different redevelopment options.

The development of a roadmap of the brownfield redevelopment process identified when decisions about the redevelopment option of a brownfield site were likely to be taken and was used to produce a list factors relating to the brownfield site and the surrounding urban area that could affect this decision.

A review of the National Garden Festivals identified that the most important factor in delivering an appropriate redevelopment option where a site is initially redeveloped for a temporary event is the planning component of the characterisation, planning and design stage of the brownfield redevelopment process. An assessment of urban models determined that it was not possible to predict the impact of brownfield redevelopment on urban area as a means of comparing alternative redevelopment options. Therefore, it was necessary to develop a new tool to compare alternative redevelopment options.

The developed tool, BRR, provides a means to assess the redevelopment options of brownfield sites in an integrated and systematic manner that considers the social, economic and environmental aspects of the redevelopment. To demonstrate that BRR

could be applied to assess brownfield redevelopment it was applied to develop a systematic objective-based model of the redevelopment of the Radford site. By analysing the effects of policy identified within the model it was identified that, at the Radford site, there was no policy requirement to assess the sustainability of the redevelopment option chosen and that conflicting policies delayed the redevelopment of the site.

BRR was applied to assess the proposed redevelopment options at three sites. At the first two sites, a single option was assessed to determine if it was appropriate. At the Shaw and Marvin site it was shown that the redevelopment option was appropriate and at the Willoughby Garages site it was shown that whilst the redevelopment option was not inappropriate, it was likely that a more beneficial option could be identified. At the third site, Basford gasworks three redevelopment options were compared and it was determined that industrial and commercial units were the most appropriate of three options.

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Contents

Abstract ..... **i**
Acknowledgements ..... **iii**
Index of figures ..... **ix**
Index of tables xiii
Glossary ..... **xiv**
List of Abbreviations and Acronyms ..... **xviii**
Chapter 1: Introduction **1**
1.1 Aim and Objectives 4
1.2 Brownfield Definitions 4
1.3 Structure of the Thesis 7
Chapter 2: Methodology **9**
2.1 Brownfield Policy 9
2.2 Brownfield Roadmap 10
2.3 National Garden Festivals 10
2.4 An Urban Simulation Approach to Assessing Brownfield Redevelopment Options 12
2.5 A Systems Approach to Assessing Brownfield Redevelopment 13
2.6 Applying a Systems Approach to Analyse the Impact of Policy on Brownfield Redevelopment 13
2.7 Applying a Systems Approach to Assess Brownfield Redevelopment Options 14
Chapter 3: Brownfield Policy **15**
3.1 What is Policy? 15
3.2 The History of Brownfield Redevelopment Policy 16
3.2.1 Derelict Land Policy 17
3.2.2 Contaminated Land Policy 19
3.2.3 Urban Regeneration Policy 22
3.2.4 Brownfields First: The Development of a Sequential Approach to the Allocation of Land for Development 24
3.2.5 Summary of Policy Objectives Related to Brownfield Redevelopment 25
3.3 Brownfield Policy in England 26
3.3.1 Delivering the Government's Brownfield Policy 27
3.4 A National Brownfield Strategy for England 32
3.5 Measuring the Success of Brownfield Policy 33
3.5.1 Brownfield Policy in England and the A-B-C Model 42
3.5.2 Of Cabbages and Chocolate: Problems with the Government's Brownfield Definition and Other Flaws in the Measurement of the Success of Brownfield Policy 44
3.6 Summary 46
Chapter 4: Towards a Brownfield Redevelopment Roadmap **48**
4.1 The Use of Roadmaps to Describe Brownfield Redevelopment 49
4.2 The Process of Redeveloping Brownfield Sites 55

4.2.1 Overview of the Brownfield Redevelopment process 55
4.2.2 Initiation Stage of Brownfield Redevelopment 57
4.2.3 The Characterisation, Planning and Design Stage of Brownfield Redevelopment 60
4.2.4 The Implementation Stage of Brownfield Redevelopment 64
4.2.5 The Completion Stage of Brownfield Redevelopment 65
4.3 Key Issues within Brownfield Redevelopment 66
4.3.1 Land Use Planning: Bringing Land Forward for Development 67
4.3.2 The appraisal of redevelopment options for brownfield redevelopment projects 67
4.3.3 Site Acquisition, Land Assembly and Brownfield Redevelopment 70
4.3.4 Development Control and Planning Permission 71
4.3.5 Managing Land Contamination within the Brownfield Redevelopment Process 75
4.3.6 Brownfield Redevelopment and Environmental Impact 77
4.3.7 Brownfield Redevelopment and Biodiversity 79
4.3.8 Brownfield Redevelopment and Flood Risk 81
4.3.9 Business Aspects of Brownfield Redevelopment 83
4.4 Summary 83
Chapter 5: National Garden Festivals 85
5.1 The National Garden Festivals as a Brownfield Regeneration Policy 85
5.2 Liverpool International Garden Festival 88
5.2.1 Redevelopment and the Festival 88
5.2.2 Post-Festival Redevelopment 89
5.2.3 The Site Today 92
5.3. The National Garden Festival Stoke ‘86 92
5.3.1 Redevelopment and the Festival 92
5.3.2 Post-Festival Redevelopment 93
5.3.3 Festival Park: The Site Today 94
5.4 Glasgow Garden Festival 1988 94
5.4.1 Redevelopment and the Festival 94
5.4.2 Post-Festival Redevelopment 95
5.4.3 Pacific Quay: The Site Today 95
5.5 Blooming success or wilted and forgotten: The long-term success of the National Garden Festivals 96
5.5.1 The Success of the National Garden Festivals 96
5.5.2 The National Garden Festivals and Sustainable Brownfield Regeneration 100
5.5 Summary 103
Chapter 6: An Urban Simulation Approach to Assess Brownfield Redevelopment Options 105
6.1 Urban Simulation as an Analysis Tool 105
6.2 Criteria for a Model to Simulate the Impact of Brownfield Redevelopment on an Area 107
6.3 Available Models 108
6.3.1 SimCity 4 108
6.3.2 UrbanSim 3 113
6.4 Evaluation of the Models against the Criteria 117
6.5 Summary 118

Chapter 7: Brownfield REMIT/RESPONSE: A Systems Approach to Analysing Urban Brownfield Redevelopment 120
7.1 Applying a Systems Approach to Urban Areas 121
7.1.1 Urban Systems 121
7.1.2 Systems Approaches That May Be Applicable To Brownfield Redevelopment.....122
7.2 REMIT/RESPONSE 125
7.3 The Operation of REMIT/RESPONSE 126
7.3.1 Establishing the Objectives 127
7.3.2 The Interaction Matrix 128
7.3.3 Identifying the Leading Diagonals.....130
7.3.4 Analytically Modelling the Generic System 133
7.3.5 Analytically Modelling the Site Specific System 134
7.3.6 Establishing the Viability of Different Options 138
7.3.7 Designing the Detail of the Project Procedures 138
7.4 The applicability of REMIT/RESPONSE to Brownfield Redevelopment.....138
7.5 Brownfield REMIT/RESPONSE: A Systems Approach to Modelling Brownfield Redevelopment Projects 141
7.5.1 Translating REMIT/RESPONSE to Brownfield Redevelopment 142
7.5.2 Describing the Site and the Urban Area.....143
7.5.3 Assessing Brownfield Redevelopment using REMIT/RESPONSE 143
7.6 Summary 146
Chapter 8: Applying Brownfield REMIT/RESPONSE to Brownfield Redevelopment 147
8.1 The Radford Site 147
8.2 Description of the Radford Area 154
8.3 Redevelopment of the Radford Site 155
8.3.1 Initiation of the Redevelopment of the Radford Site 155
8.3.2 Characterisation, Planning and Design of the Redevelopment of the Radford Site 157
8.3.3 Implementation of the redevelopment of the Radford site 158
8.3.4 Completion of the redevelopment of the Radford site 159
8.4 Applying Brownfield REMIT/RESPONSE to the Radford Site.....159
8.4.1 The Objectives of Redeveloping the Radford Site.....159
8.4.2 Identifying the Main Components of the Urban System at the Radford Site162
8.4.3 The Generic Interaction Matrix.....167
8.4.4 The Site Specific Matrix for the Radford Site 169
8.5 The Impact of Policy on the Redevelopment of the Radford Site 176
8.5.1 The 'Creation' of the Radford Site and Initiation of the redevelopment of the site 176
8.5.2 The Impact of Local Planning Policies on the Redevelopment of the Radford Site 177
8.5.3 Impact of the Development Brief on the Redevelopment of the Radford Site 181
8.5.4 The Environment Agency, Flood Risk and the Redevelopment of the Radford Site 182

8.5.5 The Impact of Development Control on the Site Characterisation at the Radford Site 183
8.6 Summary 184
Chapter 9: Assessing Brownfield Redevelopment Options with Brownfield REMIT/RESPONSE 185
9.1 The Generic Interaction Matrix 185
9.2 Shaw and Marvin Site, Beeston 189
9.2.1 Conceptual Model of the Shaw and Marvin Site 189
9.2.2 Description of Beeston Town Centre 191
9.2.3 Redevelopment Proposal for the Shaw and Marvin Site 192
9.2.4 Assessment of the Redevelopment Proposals for the Shaw and Marvin Site Using Brownfield REMIT/RESPONSE 193
9.3 Willoughby Garages Site, Beeston 196
9.3.1 Conceptual Model of the Willoughby Garages Site 197
9.3.2 Description of Beeston Town Centre 198
9.3.3 Redevelopment Proposal for the Willoughby Garages Site 198
9.3.4 Assessment of the Redevelopment Proposals for the Willoughby Garages Site Using Brownfield REMIT/RESPONSE 199
9.4 Basford Gasworks site 200
9.4.1 Conceptual Model of the Basford Gasworks Site 201
9.4.2 Description of the Area Surrounding the Basford Gasworks 202
9.4.3 Redevelopment Objectives for the Basford Gasworks Site 204
9.4.4 Redevelopment Options for the Basford Gasworks Site 204
9.4.5 Assessment of the Redevelopment Options for the Basford Gasworks Site Using Brownfield REMIT/RESPONSE 207
9.5 Summary 217
Chapter 10: Discussion 218
10.1 Event Based Regeneration: Past, Present and Future 218
10.2 An Urban Simulation Approach to Selecting Brownfield Redevelopment Options 221
10.3 A Systems Approach to Selecting Brownfield Redevelopment Options 222
10.3.1 Methodological Difficulties in Applying REMIT/RESPONSE to Brownfield Redevelopment 227
10.3.2 The Radford Site 229
10.3.3 The Generic Interaction Matrix and the Assessment of Brownfield Redevelopment Options Using Brownfield REMIT/RESPONSE 234
10.3.4 The Shaw and Marvin Site and the Willoughby Garages Site 235
10.3.5 Basford Gasworks 236
10.4 The revised Brownfield REMIT/RESPONSE methodology 237
Chapter 11: Conclusions and Further Work 241
11.1 Main Findings 241
11.2 Suggestions for Further Work 247
11.2.1 Analysis of regional and local policy impacts on redevelopment rates 247
11.2.2 Develop an Urban Model That Could be Used to Forecast the Impact of Brownfield Redevelopment 247
11.2.3 Explore the application of Brownfield REMIT/RESPONSE to design brownfield site investigations and to identify barriers to redevelopment 248

11.2.4 Asses the Sustainability of the Redevelopment Option Chosen for the Radford Site 249
11.2.5 Develop a Range of Generic Brownfield Redevelopment Matrices 249
11.2.6 Apply Brownfield REMIT/RESPONSE to the London 2012 Olympics 250
11.3 Summary 250
References 252
Appendices 273
Appendix A – Justifications for the matrix coding at the Radford site 274
Appendix B – Justifications for the matrix coding at the Shaw and Marvin site 284
Appendix C – Justifications for the matrix coding at the Willoughby Garages site 289
Appendix D – Justifications for the matrix coding at the Basford Gasworks Site 294

Index of figures

Figure 1: The six step process to develop the Opportunity Plan (After: Neonato et al., 2005) 3
Figure 2: Structure of this thesis 8
Figure 3: Regional Development Agencies of England (Adapted from: Government Office for the South East, 2007) 29
Figure 4: New dwellings on PDL, 1989 to 2005 (Data from: DTLR, 2001; DCLG, 2006; and 2007c) 34
Figure 5: Development on PDL (Data from: ODPM, 2004d; and 2005d; DCLG, 2006e) 35
Figure 6: Net annual change in stock of PDL between 2001 and 2005 (Data from ODPM, 2002; 2003a; 2004g; and 2005g; DCLG, 2006j) 36
Figure 7: Cumulative proportion of 2001 stock of PDL reclaimed by year (Data from ODPM, 2002; 2003a; 2004g; and 2005g; DCLG, 2006j) 36
Figure 8: Brownfield land redeveloped by English Partnerships and Regional Development Agencies (Data from: dti and English Partnerships) 37
Figure 9: Land changing to developed uses by previous use, 1994-2002 (Data from: ODPM, 2005d; DCLG, 2006e) 38
Figure 10: PDL in England 2001-2005 (Data from ODPM, 2002; 2003a; 2004g; and 2005g; DCLG, 2006j) 39
Figure 11: Rural land consumed for development, 1994-2001 (Data from: ODPM, 2005d; DCLG, 2006e) 39
Figure 12: Land consumed for housing development, 1995 - 2005. Land area consumed calculated using dwellings completed per year from housing statistics and density of dwellings built from Land Use Change Statistics (Data from DCLG, 2006e; 2006g; and 2007b) 40
Figure 13: Dwellings completed and area of land consumed for new dwellings, 1995 – 2005. Land area consumed calculated using dwellings completed per year from Housing Statistics and density of dwellings built from Land Use Change Statistics (Data from DCLG, 2006e; 2006g; and 2007b) 41
Figure 14: Density of new dwellings 1995-2005 (DCLG, 2006g) 41
Figure 15: The A-B-C model of brownfield sites (CABERNET, 2006) 43
Figure 16: Roadmap of the development of PDL (Adapted from Laidler et al., 2002) 51
Figure 17: Roadmap of a holistic Brownfield Regeneration project (Adapted from RESCUE, 2005) 53
Figure 18: US EPA Chart of the Brownfields Redevelopment Process Flow (Adapted from USEPA, 2001) 54
Figure 19: Conceptual model of brownfield redevelopment including the key stages 56
Figure 20: Initiation stage of brownfield redevelopment 57
Figure 21: Characterisation, Planning and Design stage of brownfield redevelopment 60
Figure 22: Implementation stage of brownfield redevelopment 64
Figure 23: Completion stage of brownfield redevelopment 65
Figure 24: Options appraisal for regeneration, renewal and regional development projects (ODPM, 2004a) 69
Figure 25: Roadmap of the English Planning Control Process (After Rydin, 2003) . 72

Figure 26: Roadmap of the contaminated land management process (After Defra and Environment Agency, 2004) 76
Figure 27: Main steps in the EIA process as part of a planning decision (RTPI, 2001) 78
Figure 28: Incorporating biodiversity into the redevelopment of a brownfield site (The South East England Biodiversity Forum, 2002; ODPM, 2006) 80
Figure 29: Flood risk and brownfield redevelopment (DCLG, 2006i) 82
Figure 30: Location of the Garden Festivals within the UK 86
Figure 31: The areas of Liverpool International Garden Festival site (Adapted from Cass, 1983) 90
Figure 32: Site master plan (Source: Pacific Quay Developments, 2007) 96
Figure 33: Summary of the success of Liverpool, Stoke and Glasgow Garden Festivals in meeting the key objectives of the National Garden Festivals 100
Figure 34: Example of a time series graph from SimCity 4 (showing a graph of the level of water pollution) 111
Figure 35: Example of a data view from SimCity 4 (showing data about the spatial distribution and level of air pollution) 112
Figure 36: Two examples of data on the status of individual buildings in SimCity 4 (showing two different sets of data about a residential property) 112
Figure 37: Structure of the UrbanSim model (Noth et al., 2003) 114
Figure 38: N^2 Chart describing relationships at a barracks (After Hitchins, 2003) 123
Figure 39: Causal Loop Model illustrating same system as Figure 38 123
Figure 40: Soft systems methodology (After Checkland and Scholes, 1990) 124
Figure 41: Generic REMIT/RESPONSE operation (After Hudson 1992) 127
Figure 42: Leading diagonals and off diagonals of the interaction matrix 128
Figure 43: Conceptual representation of the interaction matrix 129
Figure 44: An interaction matrix for a tunnelling project through rock (After Hudson and Harrison 1992) 130
Figure 45: Coarse matrix with only three components (After Hudson, 1992) 131
Figure 46: Intermediate resolution matrix (After Hudson, 1992) 132
Figure 47: Matrix coding methods 134
Figure 48: Generation of the cause and effect co-ordinates (after Hudson, 1992) .. 136
Figure 49: The C,E Diagram for N components (After Hudson, 1992 fig 4.8) 137
Figure 50: The steps in implementing Brownfield REMIT/RESPONSE Methodology 142
Figure 51: Aerial photograph of the Radford site prior to redevelopment (Source: Window Local Live) 148
Figure 52: The four areas of the Radford site with former land use and site boundaries 149
Figure 53: Location of the Radford site in Nottingham 152
Figure 54: Land uses surrounding the Radford site 153
Figure 55: Fly tipping at the car showroom area of the site 153
Figure 56: Deprivation in Radford 154
Figure 57: Roadmap of the redevelopment process at the Radford site (the colours match the stages of the redevelopment process, see Figure 19) 156
Figure 58: Detailed land use allocation outlined in the Planning Brief for the Radford site (Nottingham City Council, 2003a) 161
Figure 59: Interaction matrix showing the key components of the brownfield redevelopment system at the Radford site 163

Figure 60: Atlas of mechanisms (see CD-ROM for an expanded version of this figure) 166
Figure 61: The generic interaction matrix 168
Figure 62: The C,E diagram for the generic matrix 169
Figure 63: Binary Coded Radford Site Specific Matrix 171
Figure 64: The C, E diagram for the binary coded Radford Site Specific Matrix 172
Figure 65: Expert-semi quantitative Coded Radford Site Specific Matrix (see appendix A for justifications of the matrix coding) 173
Figure 66: The C,E diagram for the ESQ coded Radford site specific matrix 174
Figure 67: Directionality of 'Critical' interactions at the Radford site 175
Figure 68: Planning proposals map at the Radford site and immediate surroundings 179
Figure 69: The generic urban brownfield redevelopment matrix (see CD-ROM for an expanded version of this figure) 187
Figure 70: The binary coded generic urban brownfield redevelopment matrix 188
Figure 71: The C,E diagram for the binary coded generic urban brownfield redevelopment matrix 189
Figure 72: Location of the two Beeston sites 190
Figure 73: Perturbation caused by the proposed redevelopment of the Shaw and Marvin site 193
Figure 74: Binary coded site specific matrix for the Shaw and Marvin Site 194
Figure 75: The C,E diagram for the binary coded site specific matrix for the Shaw and Marvin Site 195
Figure 76: Expert-semi quantitative coded site specific matrix for the Shaw and Marvin site 196
Figure 77: Perturbation caused by the proposed redevelopment of the Willoughby Garages site 199
Figure 78: Expert semi-quantitative coded site specific matrix for the Willoughby Garages Site 200
Figure 79: Location of the Basford Gasworks Site in Nottingham 201
Figure 80: Perturbation caused by the proposed redevelopment of the Basford Gasworks site for industrial and commercial units 205
Figure 81: Perturbation caused by the proposed redevelopment of the Basford Gasworks site for a food retail superstore 206
Figure 82: Perturbation caused by the proposed redevelopment of the Basford Gasworks site for family housing 206
Figure 83: The binary coded site specific matrix for the redevelopment of the Basford Gasworks site for industrial and commercial units 208
Figure 84: The C,E diagram for the binary coded site specific matrix for the redevelopment of the Basford Gasworks site for industrial and commercial units 209
Figure 85: The expert-semi quantitative coded site specific matrix for the redevelopment of the Basford Gasworks site for industrial and commercial units 210
Figure 86: The binary coded site specific matrix for the redevelopment of the Basford Gasworks site for a food supermarket 211
Figure 87: The C,E diagram for the binary coded site specific matrix for the redevelopment of the Basford Gasworks site for a food supermarket 212
Figure 88: The expert-semi quantitative coded site specific matrix for the redevelopment of the Basford Gasworks site for a food superstore 214
Figure 89: The binary coded site specific matrix for the redevelopment of the Basford Gasworks site for housing 215

Figure 90: The C,E diagram for the binary coded site specific matrix for the redevelopment of the Basford Gasworks site for a food supermarket 216
Figure 91: The expert-semi quantitative coded site specific matrix for the redevelopment of the Basford Gasworks site for housing 217
Figure 92: Comparison between the National Garden Festival redevelopment process and the redevelopment roadmap 219
Figure 93: A matrix with mixed resolutions illustrating how different scales of analysis could be incorporated in a single matrix 227
Figure 94: Comparison between the redevelopment process at the Radford site and the generic redevelopment roadmap 229
Figure 95: Modified roadmap of redevelopment process at the Radford site..... 230
Figure 96: Comparison between the redevelopment process at the Shaw and Marvin, and Willoughby Garages Sites and the redevelopment roadmap..... 235
Figure 97: Comparison between the redevelopment process at the Basford Gasworks Site and the redevelopment roadmap 236
Figure 98: The Brownfield REMIT/RESPONSE systems approach to selecting an appropriate redevelopment option for a brownfield site 238

Index of tables

Table 1: Acts of Parliament containing powers relating to derelict land consolidated by the Derelict Land Act, 1982 18
Table 2: The phases of urban policy (Adapted from Rydin, 2003) 22
Table 3: History of the target for new housing on PDL (Sources: Samworth, 1986; DoE, 1995; DoE, 1996; DETR, 1998; ODPM, 2003b; and 2005h; DCLG, 2006a). 24
Table 4: History of the sequential test in planning policy (Sources: DoE, 1994; DETR, 1998; POST, 1998; Urban Task Force, 1999; DETR, 2000b) 25
Table 5: Objectives of derelict land, contaminated land, urban regeneration and land allocation policy relevant to brownfields 26
Table 6: Motivation of stakeholders for redeveloping a brownfield site (English Partnerships, 2006a) 58
Table 7: Brownfield site properties investigated during site characterisation 61
Table 8: Properties of urban areas that may be investigated during site characterisation 62
Table 9: Issues addressed within detailed design 64
Table 10: Site assembly options (Harpum, 2000; English Partnerships, 2006a) 70
Table 11: Reserved matters in relation to outline planning permission (DCLG, 2006b) 73
Table 12: Information that must be included in an Environmental Statement (ODPM, 2000) 79
Table 13: The key objectives of the festivals adapted from (PA-Cambridge-Economic-Consultants, 1990). 86
Table 14: Evaluation of the models against the required criteria 118
Table 15: Evaluation of the representation of development within the model against the required criteria 118
Table 16: A typology of impacts caused by urban brownfield redevelopment 120
Table 17: Evaluation of the systems approaches reviewed 125
Table 18: Descriptive conceptual model of the Radford site 149
Table 19: Policy constraints at the Radford site (Nottingham City Council, 2001; and 2005c) 160
Table 20: Site constraints at the Radford site (Nottingham City Council, 2001; and 2005c) 160
Table 21: Nottingham Local Plan Policies affecting the Radford site (Nottingham City Council, 2005c) 178
Table 22: Land use policies and allocations at the Radford site 179
Table 23: Descriptive conceptual model of the Shaw and Marvin site 190
Table 24: Profile of Broxtowe Borough (2001 census data unless stated) 191
Table 25: Descriptive conceptual model of the land at the Willoughby Garages Site 197
Table 26: Descriptive conceptual model of the Basford Gasworks site 201
Table 27: Profile of the Berridge and Basford area of Nottingham (all figures for 2001 except where stated) 203
Table 28: Redevelopment options for the Basford Gasworks site 205

Glossary

Brownfield: Sites which:

have been affected by former uses of the site or surrounding land;

are derelict or underused;

are mainly in fully or partly developed urban areas;

may have real or perceived contamination problems; and

require intervention to bring them back to beneficial use (CABERNET, 2007)

Brownfield redevelopment: the process or action of converting a brownfield site for a new use (see section 1.1)

Brownfield regeneration: urban regeneration that is delivered through brownfield redevelopment (see section 1.1)

Contaminated land: In England and Wales the statutory definition is "any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on, or under the land, that: (a) significant harm is being caused or there is a significant possibility of such harm being caused; or (b) significant pollution of controlled waters is being caused or there is a significant possibility of such pollution being caused" (Part 2A, s.78A(2) of EPA, 1990; as amended by the Water Act, 2003)

Derelict buildings: Abandoned and unoccupied buildings in an advanced state of disrepair (NLUD, 2003)

Derelict land: there is no statutory definition of derelict land but its established administrative definition is "land so damaged by industrial or other development that is incapable of beneficial use without treatment" where treatment includes any of the

following: demolition, clearing of fixed structures or foundations and levelling (DoE, 1975; NLUD, 2003).

Greenfield: A greenfield is any site not classified as previously developed land. Therefore it is any site that has not been previously developed, or has been developed for agricultural or forestry purposes.

Hard-end uses: Uses comprising buildings together with associated infrastructure (English Partnerships, 2006a)

Previously developed land: "Previously-developed land is that which is or was occupied by a permanent structure, including the curtilage of the developed land and any associated fixed surface infrastructure." (DCLG, 2006h)

The definition includes defence buildings, but excludes:

- Land that is or has been occupied by agricultural or forestry buildings;
- Land that has been developed for minerals extraction or waste disposal by landfill purposes where provision for restoration has been made through development control procedures;
- Land in built-up areas such as parks, recreation grounds and allotments, which, although it may feature paths, pavilions and other buildings, has not been previously developed, and;
- Land that was previously-developed but where the remains of the permanent structure or fixed surface structure have blended into the landscape in the process of time (to the extent that it can reasonably be considered as part of the natural surroundings).

Reclamation: the process of treating derelict land (DoE, 1984). Reclamation differs from redevelopment in that site is not necessarily converted to a new use, just treated so it is suitable for development.

Regeneration: There is no commonly agreed definition of regeneration but two good definitions are that regeneration is "the process of rectifying and managing an areas internal problems by enhancing its development opportunities to combat results of uneven socio-economic development" (Lee, 2006) and "the process of turning round deprived communities in decayed neighbourhoods" (Brown, 2003).

Remediation: Under the Part 2A regime this is defined as

> "(a) the doing of anything for the purpose of assessing the condition of— (i) the contaminated land in question; (ii) any controlled waters affected by that land; or (iii) any land adjoining or adjacent to that land;
>
> (b) the doing of any works, the carrying out of any operations or the taking of any steps in relation to any such land or waters for the purpose— (i) of preventing or minimising, or remedying or mitigating the effects of, any significant harm, or any pollution of controlled waters, by reason of which the contaminated land is such land; or (ii) of restoring the land or waters to their former state; or
>
> (c) the making of subsequent inspections from time to time for the purpose of keeping under review the condition of the land or waters" (Environmental Protection Act, 1990; as amended by Environment Act, 1995)

Soft end uses: Recreational uses and public open space, which may include a limited amount of building or infrastructure (English Partnerships, 2006a)

Vacant building: buildings that are structurally sound and in a reasonable state of repair (i.e. capable of being occupied in their present state) where re-letting for their former use is not expected or that have been declared redundant (National Land Use Database (NLUD), 2003).

Vacant land: land that could be redeveloped without treatment where treatment includes any of the following: demolition, clearing of fixed structures or foundations and levelling (National Land Use Database (NLUD), 2003)

List of Abbreviations and Acronyms

Brownfield REMIT/RESPONSE – The brownfield redevelopment systems approach developed in this thesis
BRR - Brownfield REMIT/RESPONSE
CABERNET – Concerted Action on Brownfield and Economic Regeneration NETwork
CLARINET - Contaminated Land Rehabilitation Network for Environmental Technologies in Europe
DCLG – Department for Communities and Local Government
Defra – Department for Environment, Food and Rural Affairs
DETR – Department of the Environment, Transport and the Regions
DoE – Department of the Environment
dti – Department of Trade and Industry
DTLR - Department for Transport Local Government and the Regions
EPA 1990 – Environmental Protection Act 1990
ESQ – Expert semi-quantitative
ICRCL – Interdepartmental Committee for the Redevelopment of Contaminated Land
NLUD – National Land Use Database
ODPM – Office of the Deputy Prime Minister
ONSE – Objective-based Network Sequence Evaluation
Part 2A – Part 2A of the Environmental Protection Act 1990
PDL - Previously developed Land
PPG – Planning Policy Guidance Note
PPS – Planning Policy Statement
RDA – Regional Development Agency
REMIT – Rock Engineering Mechanisms Information Technology
REMIT/RESPONSE – The rock engineering systems approach developed by Hudson (1992)
RESP – Rock Engineering Systems Performance
R^2 – REMIT/RESPONSE
Radford Site – 'The Radford Goods Yard, Chettle's Yard and area' site
RESCUE – Regeneration of European Sites in Cities and Urban Environments

Chapter 1: Introduction

Brownfield sites are the physical manifestation of economic structural changes such as the decline or relocation of traditional industries (Ferber and Grimski, 2002). A site can become a brownfield if, following the cessation or reduction of activity on it, it is not put to a new use, either through re-use or redevelopment. For further discussion of the creation of brownfield sites see Gorman (2003). In addition, if maintenance is not carried out the site can become derelict as buildings, infrastructure and other physical components of the site deteriorate. They can have a blighting effect on urban areas, attract anti-social behaviour and crime, be subject to fly-tipping and can be a risk to human health (Ferber and Grimski, 2002; Hull Biodiversity Partnership, 2002; De Sousa, 2003).

Although brownfield redevelopment is primarily a physical process it must address a range of social, environmental and economic problems to contribute successfully to urban regeneration. Barriers that inhibit brownfield redevelopment include obsolete buildings, reduced land values, poor ground conditions, contamination (although brownfield sites are not necessarily contaminated), retention of sites by landowners, fragmented land ownership, poor location, inappropriate zoning, poor market conditions, lack of available funding and unsupportive planning regimes (Adams et al., 1997; McGarty, 1999; Rogers and Power, 2000; Syms, 2001; Barker, 2003). There are also factors that may contribute to reducing the appeal of developing a site including the loss of habitats, increased traffic, loss of historic features, landscapes or buildings (Carroll, 2002). In order for redevelopment to be successful the relevant barriers – based on a project's objectives - must be overcome making brownfield redevelopment apparently more complex than developing a greenfield site.

Despite these difficulties brownfield redevelopment is promoted not only as end in itself but as a means of contributing to the regeneration of urban areas, the sustainable growth of urban communities and the sustainable use of land (POST, 1998; Urban Task Force, 1999; DETR, 2000a; Rogers and Power, 2000; Ferber and Grimski, 2002; Thomas, 2002; Dorsey, 2003; ODPM, 2003b). For brownfield redevelopment to contribute to these wider goals the redevelopment options for a site must be identified and an, if not the most, appropriate redevelopment option chosen.

Previous research has recognised the importance of selecting the appropriate redevelopment option for a brownfield site and has provided a method to identify the range of options from which the appropriate option can be chosen. Alker et al. (2000a) identified that there was no method available to assess brownfield sites to determine the most appropriate end use for redevelopment and that such a method would enable best value judgments to be made within the planning framework. Ferber and Grimski (2002) identified that the determination of the appropriate after-use, or opportunity, for a brownfield sites is the core component of a successful redevelopment project but do not propose any methods or tools to select the most appropriate after-use. Neonato et al. (2005), as part of the work of the CABERNET network, propose a method that can be used to select the preferred option for the redevelopment of a brownfield site, the “opportunity plan”.

The opportunity plan is an informed review of a brownfield within its context that allows the brownfield process manager (the person managing redevelopment) to explore the needs for redevelopment and regeneration and identify a series of redevelopment options for a brownfield site. Neonata et al. propose a six step process to develop the opportunities plan (Figure 1) and propose that a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis should be carried out to identify the

redevelopment options but do not provide a method to compare alternative options or determine which is most appropriate for a particular site. Options appraisal in redevelopment projects typically focuses on the likely return on investment, either economic return or in terms of regeneration objectives, but does not seek to identify the most appropriate redevelopment option for a site (see section 4.3.2). Therefore, there is a need for a method to determine which redevelopment option, or combination of options, is most appropriate for a brownfield site.

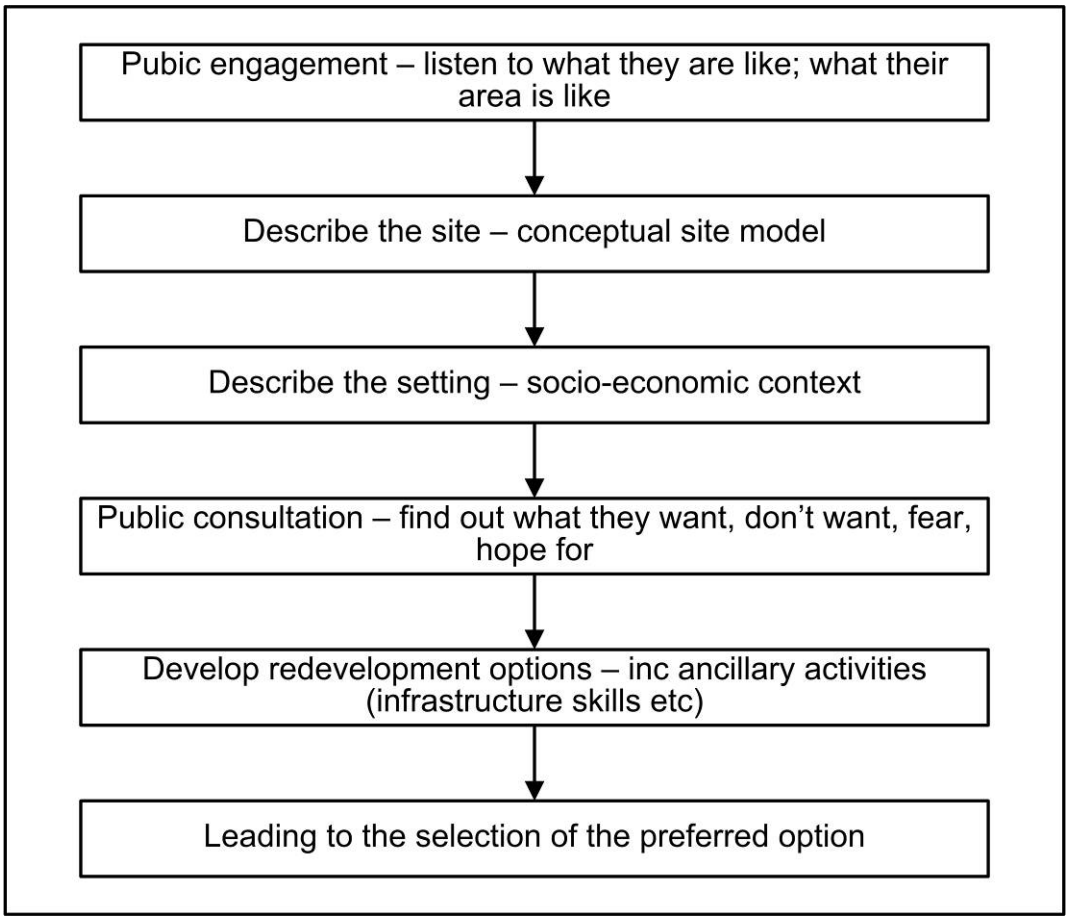


Figure 1: The six step process to develop the Opportunity Plan (After: Neonato et al., 2005)

The research presented within this thesis has been carried out to investigate how the most appropriate redevelopment option for a brownfield site can be determined (the final step in the opportunity plan process). Specifically it has focused on the interaction between information, policy and the redevelopment process and how this affects the redevelopment option that is most appropriate.

The problem being addressed in this thesis is:

How can an appropriate redevelopment option for an urban brownfield site be determined?

1.1 Aim and Objectives

The aim of the thesis is to develop a method for selecting an appropriate redevelopment option for a brownfield site.

The specific objectives are:

1. To determine if the National Garden Festivals can provide any lessons for delivering the most appropriate redevelopment option for brownfield sites over the long-term (Chapter 5);
2. To establish whether urban simulation can determine the most appropriate redevelopment option for a brownfield site (Chapter 6);
3. To develop a tool to assess the redevelopment of urban brownfield sites (Chapter 7);
4. To apply the developed tool to determine how policy can influence the redevelopment of a brownfield site (Chapter 8), and;
5. To apply the tool to assess and compare the redevelopment options for brownfield sites to select an appropriate redevelopment option for a site (Chapter 9)

1.2 Brownfield Definitions

Despite being used regularly in Government communications, the term brownfield has not been defined by the Government in England. The term is frequently used interchangeably with Previously Developed Land (PDL) – even though the two are not the same. PDL is defined as land which is or was occupied by a permanent

structure (excluding agricultural or forestry buildings), and associated fixed surface infrastructure and includes the curtilage of the developed land (see glossary for full definition) (DCLG, 2006h). Further weight has been added to this definition as it has been adopted by English Partnerships in their role as the Government's special advisor on brownfield land and has been adapted to provide a definition of a brownfield as part of the development of a national brownfield strategy (see section 3.4.1) (English Partnerships, 2003; English Partnerships, 2006a).

Although there is no consensus on a definition of a brownfield, in this research they are considered to be sites which:

Have been affected by former uses of the site or surrounding land;

Are derelict or underused;

Are mainly in fully or partly developed urban areas;

May have real or perceived contamination problems, and;

Require intervention to bring them back to beneficial use (CABERNET, 2007).

This definition is based on a definition proposed by Ferber and Grimski (2002) and has been adapted by CABERNET, Europe's network of experts on brownfield regeneration, to reflect that brownfield sites are not necessarily contaminated. Further to the above definition, this research focuses on urban brownfield sites and therefore excludes rural brownfield sites.

Nathanail et al (2003) provide a discussion of brownfield definitions from an international perspective while Alker et al. (2000b) and Yount (2003) discuss the need for a robust definition and propose one for use in the UK and the US respectively. Alker el al. also discuss problems caused by a lack of an agreed brownfield definition including the confusion and misunderstanding caused by different stakeholders

adopting different definitions of brownfields sites. The result of a lack of a statutory definition, or a consistently applied definition in national policy, is that a plethora of definitions have been adopted across England in different policy contexts. It has been suggested that any policy on brownfield sites is pointless without a definition of what one is (Hanham, 1997). This is a situation that has yet to be resolved in England and despite this the Government persists in using the term brownfield, usually as a synonym for PDL (for example, see Secretary of State for Communities and Local Government Kelly, 2006; or DCLG et al., 2007). The definition of PDL does not require land to be vacant or derelict and this is reflected in the classification of land in the record of PDL that may be available for development in England (NLUD-PDL) (DCLG, 2006j), which includes the following five categories:

Vacant land;

Derelict land and buildings;

Vacant buildings;

Land currently in use with planning allocation or permission, and;

Other land currently in use with known redevelopment potential.

Brownfield redevelopment and brownfield regeneration are both frequently used terms that are, in general, loosely defined and often used interchangeably. However, within this thesis they are considered to have specific meanings. Brownfield redevelopment is taken to mean the process or action of converting a brownfield site for a new use and brownfield regeneration is taken to mean addressing urban problems through improvements in the economic, physical, social and environmental condition of an area that are delivered through brownfield redevelopment (this is based on a definition of urban regeneration by Roberts and Sykes, 2000)

1.3 Structure of the Thesis

This thesis comprises eleven chapters, as illustrated in Figure 2. Chapter 1 introduces brownfield sites and their redevelopment and justifies why a method is required to determine the most appropriate redevelopment options for a brownfield site. Chapter 2 introduces the methodologies used within this research. Chapter 3 and Chapter 4 review the literature pertinent to this research. Chapter 3 reviews the literature relevant to brownfield policy. Chapter 4 reviews the literature relevant to the process of brownfield redevelopment. Chapter 5 marks the start of the original research presented within this thesis. It addresses the first objective of the research by evaluating the National Gardens Festivals with particular focus on the long term re-use of the brownfield sites. Chapter 6 addresses the second objective by determining if urban simulation can evaluate alternative urban land use policies to facilitate the selection of the preferred policy or combination of policies and therefore the most appropriate redevelopment option for brownfield sites. Chapter 7 addresses the third objective by adapting REMIT/RESPONSE to create a systems-based approach to assess the redevelopment of a brownfield site. Chapter 8 addresses the fourth objective by applying the tool developed in chapter 7 to the redevelopment of the 'Radford Goods Yard, Chettle's Yard and area' site to determine the impact of policy on the redevelopment and how this affected the redevelopment option chosen. Chapter 9 addresses objective five by applying the tool developed in chapter 7 to assess the redevelopment options at three brownfield sites. Chapter 10 interprets the results of this research and determines how an appropriate redevelopment option for a brownfield site can be selected and the information that is required for this. Finally, Chapter 11 draws conclusions from the research and proposes ideas for future research.

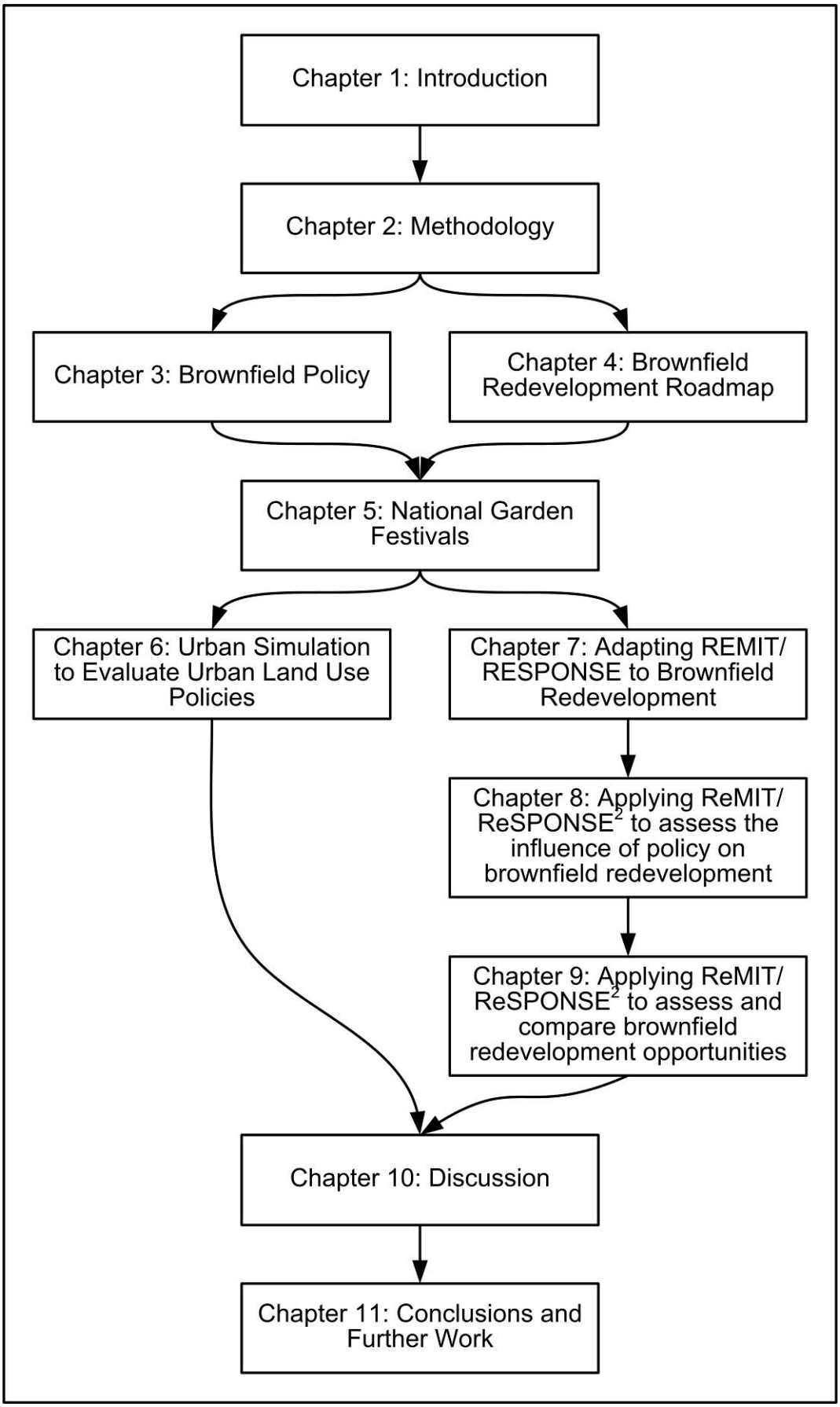


Figure 2: Structure of this thesis

Chapter 2: Methodology

This chapter will examine the methodologies used to meet the aim and objectives of this research (see section 1.3).

2.1 Brownfield Policy

The first stage of selecting a redevelopment option for a site involves establishing what it is you are trying to achieve as the most appropriate opportunity will depend on this aim. For example, the most appropriate after use may not be the same if the objective is to bring about wider regeneration as it would be if the objective is to make a short-term profit. Policy is one of the key drivers of brownfield redevelopment and can set a variety of redevelopment objectives. To determine the policy objectives of redeveloping brownfield sites in England, a review was carried out of relevant policy documents and literature (chapter 3). This review covered the history of brownfield redevelopment policy in England to identify how policy objectives have developed (see section 3.2), the current policy objectives (section 3.3) and how these objectives are delivered (section 3.3.1). Particular attention was placed on the role of planning policy and regeneration agencies in brownfield redevelopment. This review has also examined the impact of European policy on brownfield redevelopment in England and the on-going development of a national brownfield policy for England. The final component of this review evaluated the success of the current policy using data from the National Land Use Database, the Land Use Change Statistics, other Government sources and relevant literature. The policy objectives identified in this review were used in the two approaches examined to assess brownfield redevelopment options (see chapters 6, 7 and 8).

2.2 Brownfield Roadmap

Decisions about the redevelopment option for a brownfield site are made at a number of stages during the process of brownfield redevelopment and by different stakeholders. To determine when these decisions are made, and what information is relevant to them, a roadmap of the brownfield redevelopment process was developed through a review of relevant literature which was supplemented, where necessary, by reviewing brownfield redevelopment case studies (chapter 4). As well as identifying when redevelopment option decision-support tools were required in the redevelopment process, the review produced a list of the factors relevant to decisions made about the redevelopment option for brownfield sites (section 4.2.3, Table 7 and Table 8). This list formed the basis of a list of brownfield properties required for the development of a systems approach to assess brownfield redevelopment options (see section 2.5 and chapter 7).

2.3 National Garden Festivals

Before developing new tools to select an appropriate redevelopment option for a brownfield site it was felt that it was necessary to evaluate whether past redevelopment had led to regeneration opportunities being realised over the long-term (chapter 5). The National Garden Festivals of the United Kingdom were chosen for this evaluation as the same redevelopment concept was applied in different locations with varying degrees of success. Therefore, it was felt that it may be possible to identify which features of the redevelopment policy and its application had caused the differing degrees of success in achieving regeneration in the long-term.

The evaluation of the National Garden Festivals consisted of three parts:

1. A review of the policy behind the National Garden Festivals;

2. A review of each garden festival including the history of each from initiation to the present day, based on secondary data sources, and;
3. An evaluation of the success of the National Garden Festivals as a brownfield policy.

The review of the policy of the National Garden Festivals (sections 5.2, 5.3 and 5.5) involved a comprehensive search which included House of Commons debates, ministerial questions and contemporary Government documents but it was not always possible to obtain the original documents outlining the policy, and reliable secondary sources had to be used where the original documents were not available. Similar problems obtaining historic documents were experienced in the collection of data related to the individual garden festivals although in general this was not a significant problem.

The first part of the evaluation consisted of assessing each festival against the objectives of the National Garden Festivals policy to determine if a garden festival was an appropriate redevelopment option for the site (section 5.5.1). It is considered that if a garden festival was an appropriate redevelopment option then the policy objectives would have been met over the long-term. A second evaluation (section 5.5.2) was carried out to assesses the Stoke and Liverpool festivals against the RESCUE definition of Sustainable Brownfield Regeneration (RESCUE, 2005).

The results of this evaluation were used to draw conclusions about redevelopment of brownfield for short-term uses and how this can influence brownfield regeneration over the long-term (section 10.1).

2.4 An Urban Simulation Approach to Assessing Brownfield Redevelopment Options

To test the hypothesis that the most appropriate redevelopment option for a brownfield site can be determined by using urban simulation to consider alternative land use policies at the Local Authority scale it was first necessary to determine whether urban simulation can be used to model post-industrial urban land management (chapter 6).

Urban simulation was considered as an appropriate means to determine the most appropriate redevelopment option because it, potentially, provided a means to assess and compare alternative land use options for brownfield sites across a relatively wide geographical area. By considering the outcome of different combinations of redevelopment options for different brownfield sites its was felt that it would be possible to determine which was the most appropriate redevelopment option for each brownfield site within a Local Authorities area. It was also considered that it would be possible to carry out this assessment under alternative future scenarios, such as for example, different economic and demographic forecasts.

To determine if urban simulation could carry out this analysis a three stage methodology was implemented:

1. Identification of the requirements of an urban model to evaluate the impact of brownfield redevelopment on an urban area (section 6.2);
2. A literature based search to identify the available urban models (section 6.3);
3. An assessment of the available models against the requirements to determine if any models are suitable to carry out the analysis (section 6.4).

2.5 A Systems Approach to Assessing Brownfield Redevelopment

The first stage of developing a tool to determine an appropriate redevelopment option for a brownfield was to identify a method or tool that could evaluate brownfield redevelopment, or could be adapted to do so (Chapter 7). This was done by identifying what was required of a method to carry this out and then carrying out a literature based review to identify if any methods were available that met the criteria (section 7.1 to 7.3). Once a suitable method has been identified, the second stage of developing the tool involved adapting the methodology so that it could be applied to evaluate brownfield redevelopment options (section 7.4 and 7.5). The identified method required a list of brownfield properties and a list of mechanisms describing how brownfield redevelopment interacts with the surrounding urban area which were developed by reviewing the relevant literature (sections 4.3.2, 7.4.2, 8.4.2, 9.1 and 9.4.5).

2.6 Applying a Systems Approach to Analyse the Impact of Policy on Brownfield Redevelopment

To establish whether the developed tool could be applied to assess brownfield redevelopment and to determine how policy can influence the redevelopment of a brownfield site, an application of the developed tool was carried out retrospectively on a site already undergoing redevelopment (chapter 8). Before applying the tool, a conceptual model of the site and a roadmap of the redevelopment process where developed through analysis of planning files and other documentation (sections 8.1, 8.2 and 8.3). The developed tool was then applied to determine the influence of policy

on the redevelopment of the site (section 8.4) and further analysis was carried to explore the impact of policy in more detail (section 8.5).

2.7 Applying a Systems Approach to Assess Brownfield Redevelopment Options

To determine if the developed tool could be applied to assess and compare redevelopment options a generic matrix of brownfield redevelopment impacts was developed and applied at three sites (Chapter 9). The first two applications (section 9.2 and 9.3) were relatively simple and were performed to establish whether the tool could assess the impact of redeveloping a brownfield site for a particular after-use. The third application (section 9.4) was more comprehensive and was carried out to establish whether the tool could be used to compare alternative brownfield redevelopment options and illustrate how the tool could be applied to select which of them was most appropriate.

Chapter 3: Brownfield Policy

This chapter reviews Government policy which supports brownfield redevelopment and regeneration in England, in order to determine the policy objectives. It begins with a short introduction to "policy" followed by a review of the history of brownfield policy including the objectives of policies that have merged to form brownfield policy. The main section of this chapter introduces the objectives of brownfield policy in England and how the policy is delivered. This is followed by a description of the development of a National Brownfield Strategy for England. The chapter concludes with an assessment of the success of brownfield policy in England. It should noted that although brownfield policy for England and Wales has a shared history following devolution each now its only brownfield policy.

3.1 What is Policy?

Policy is defined as:

"A course of action adopted and pursued by a government, party, ruler, statesman, etc.; any course of action adopted as advantageous or expedient" (Oxford English Dictionary (OED), 1989a)

In addition to this definition, it can be expected to help address a goal, problem or concern (Torjman, 2005) and that it is contained within statements, strategies and plans (Rydin, 2003). Therefore, *brownfield policy* is taken to mean the course of action adopted and pursued by the Government that:

Encourages brownfield regeneration or the redevelopment of brownfield sites;

Affects the brownfield redevelopment process, or;

Discourages the creation of brownfield sites.

This chapter will focus on policy that encourages brownfield regeneration and the redevelopment of brownfield sites. Policies that affect the brownfield redevelopment process will be addressed in Chapter 4. Policies that prevent the creation of brownfield sites are not considered to be within the scope of this thesis.

3.2 The History of Brownfield Redevelopment Policy

This section reviews how policy on derelict land, contaminated land, urban regeneration, and development land converged to form brownfield policy to establish what objectives for brownfield redevelopment are associated with them.

Brownfield regeneration and the objectives underpinning it are not new concepts:

> "On the edge of the Black Country there is an area of really useful agricultural land. The local authorities want to take that for what they call development. Our [The Ministry of Agriculture and Fisheries] officials have been going into it and they have found that there are about 8600 acres of absolutely derelict land, slag heaps, abandoned factories, everything that makes any one of you reluctant to go and live in the Black Country. We found that by the use of modern civil engineering techniques 8000 out of those 8600 acres of derelict land could be restored for housing, open spaces, schools and playgrounds." The Rt. Hon. R. S. Hudson, Minister of Agriculture and Fisheries speaking during a discussion on minerals and planning as part of a meeting of the Royal Geographical Society on 20th November 1944 (Clerk et al., 1944)

Hudson illustrates that protecting the countryside through the redevelopment of land has been considered within policy circles for over sixty years.

> "Two hundred years ago the industries of the area were based on local coal and iron. Mine, quarry, slag heap, forge and furnace along canal and railroad

> were the main expressions of this era and have left their legacy in the form of derelict land and urban sprawl in the Black Country…
>
> …more than one tenth of the Black Country is classed as derelict. It is suggested that there is adequate room in the area for redevelopment by the control of future building and by the redevelopment of the urban nuclei…
>
> …The report [which Dickinson is reviewing] concludes with special planning proposals for the future landscape of a derelict area" (Dickinson, 1950)

This quotation, and the report that Dickinson is reviewing, illustrate that dereliction and urban sprawl have been recognised as a legacy of industrial development for more than half a century and that areas suffering from widespread dereliction may require targeted policies to regenerate them.

3.2.1 Derelict Land Policy

Wallwork (1974) argues that very little derelict land (see glossary for definition) was redeveloped as a result of the Town and Country Planning Act (1944) and The National Parks and Access to the Countryside Act (s.97, 1949) that included powers intended to tackle derelict land. He states that only forty hectares of derelict land were redeveloped in Wales between 1960 and 1966 while 153 hectares were redeveloped in 1967 alone.

This rapid rise was a consequence of a tragic disaster (144 people were killed when a colliery waste tip slid onto the village of Aberfan (Davies, 1969)) in October 1966. Aberfan raised public awareness of the dangers of land damaged by industrial activities and, despite the tip not being derelict, the Government responded by promoting the redevelopment of derelict land (Bradshaw, 1989; Hester and Harrison, 1997). To supplement existing powers (s.9 Local Employment Act, 1960; s.20

Industrial Development Act, 1966), the *Local Government Act* (s.9, 1966) and the *Local Employment Act* (s.2, 1970) provided increased and more widely available derelict land grants. These grants were not included in restrictions placed on public spending in the early 1970s thus illustrating the importance the Government placed on tackling the issue of derelict land (Wallwork, 1974).

In the late 1970s, concern about the decline of Britain's cities grew (DoE, 1977) and this led to a policy that emphasised the role of the re-use of land in urban regeneration and relieving development pressure on the countryside (DoE, 1985; DoE, 1986; Tym and Partners, 1987). The Derelict Land Grant Act (1982) was introduced to reduce the total "wasteland" (i.e. land that was derelict or underused) (DoE, 1986) and consolidated the existing powers (Table 1) into a single act and, by the late 1980s, grants were seen more as a means to unlock development opportunities than to tackle any hazards posed by the sites (DoE and Department of Employment, 1988). Since 1994, when the grants ceased, derelict land policy has been delivered through English Partnerships, Regional Development Agencies and other regeneration schemes (Hughes, 2001; English Partnerships, 2006c).

Table 1: Acts of Parliament containing powers relating to derelict land consolidated by the Derelict Land Act, 1982

National Parks and Access to the Countryside Act (1949)
Local Authorities (Land) Act (1963)
Local Government Act (1966)
Countryside Act (1968)
Town and Country Planning Act (1971)
Local Employment Act (1972)
Industry Act (1972)
Local Government Act (1974)
Local Government, Planning and Land Act (1980)

In summary, the objectives of derelict land policy relevant to brownfield redevelopment are:

To tackle the risks associated with derelict land, and;

To reclaim derelict land to relieve pressure on the countryside and provide land for development in urban areas.

3.2.2 Contaminated Land Policy

A number of serious incidents brought the threat posed by chemicals within land to the public and political consciousness. Love Canal, USA, was used as a landfill to dispose of chemical waste and was subsequently developed for a housing estate (USEPA, 1988). In 1977, following heavy rainfall, severe leaching of chemicals resulted when waste–disposal drums broke the ground surface and there was widespread death of vegetation, and pools of noxious substances appeared at the surface (State of New York Office of Public Health, 1978). Scientists of the USEPA found eighty-two toxic substances in samples taken near the landfill (USEPA, 1979) and the site became headline news after an increase in birth defects (Vianna and Polan, 1984; Goldman et al., 1985), cancer and miscarriages (Beck, 1979; Pearce, 1992). In August 1978, Love Canal was declared a State Emergency area and in May 1980 it was declared a Federal Emergency (USEPA, 2003).

In Lekkerkerk, Netherlands, eight-hundred residents were evacuated from a housing estate in 1980, which was built on a site where ditches had been filled with rubble that was later found to contain chemical waste (Brinkmann, 1981; Pearce, 1992; DeLange, 1996).

These two events stimulated the introduction of legislation and concerted efforts to manage the hazards of contaminated land. In the United States, the Government introduced the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (1980) or “Superfund” as it is more commonly known (LaGrega et al., 2001; United States Environmental Protection Agency (USEPA), 2006). In the Netherlands, legislation to control the dumping of waste was introduced and many

sites were determined as contaminated land and remediated at an estimated cost of a hundred billion guilders (Raven and Verbong, 2004).

High profile incidents led contaminated land to be perceived as relatively rare but with potentially serious consequences for human health and the environment with Government response being to seek maximum risk control by removing or containing contamination completely (Ferguson, 1999; Kasamas et al., 2001). Over the next twenty years it became apparent that the problem was more wide spread with varying degrees of potential consequences and it became clear that remediating all sites to background levels was not economically feasible (Ferguson, 1999; Kasamas et al., 2001). In Europe, this led to a new risk based land management approach which was based on the risk presented by a site (Vegter et al., 2002).

In the UK, Local Authorities, such as the Greater London Council and Leicester City Council, became concerned about redevelopment after contamination was discovered at a number of former industrial sites being redeveloped, and sought advice on the human health risks from the Department of Health and Social Security and the Department of the Environment (Harris, 1987; CIRIA, 1997). In response, the Government established the Inter-Departmental Committee on the Redevelopment of Contaminated Land (ICRCL)[1] to co-ordinate and make advice available to Local Authorities (ICRCL, 1987).

ICRCL established an advisory service on the redevelopment of contaminated land and sought to increase the knowledge and information about it by publishing

[1] The ICRCL included members from the Department of the Environment (including the Building Research Establishment and the Property Services Agency), the Department of Health and Social Security, the Welsh Office, the Scottish Office and the Health and Safety Executive

guidance, supporting research, and initiating open debate (ICRCL, 1987). One of its most significant actions was to publish guideline information to assist in determining whether land was contaminated (ICRCL, 1987). Harris (1987) argues that the ICRCL encouraged an approach where development plans were decided after site assessment to reduce the risk of hazard to users of the site. This suggests a risk based philosophy was adopted during the embryonic stages of UK contaminated land policy. Harris (1987) also suggests that policy conflicts within the Department of the Environment "may have influenced the ICRCL to urge Local Authorities not to over-react to contaminated land" to ensure it did not restrict the supply of land or discourage private investment.

A great deal has been written on the development of a new contaminated land regime, with Harris and Denner (1997), Bell and McGillivray (2000), Lowe and Lowe (2001) and Nathanail and Bardos (2004) providing narratives. This established a method to deal with the legacy of contaminated land in the UK and included the first statutory definition (see glossary).

It can be said that policy in England developed in response to a need for advice on redevelopment of sites and this led to an approach that promotes the management of contaminated land to ensure a supply of land for urban development without risking the health of future occupants. The regime developed in the 1990s is still in place today and the Government's policy is that contaminated land should made suitable for the use it is or will be used for (Defra, 2006). However, it should be stressed that, despite the frequent misuse of the term brownfield to mean a contaminated site, a brownfield is not necessarily contaminated and that brownfield redevelopment does not necessarily involve remediation.

3.2.3 Urban Regeneration Policy

Although Parkinson et al (2006) suggest that there has been a national urban policy in the UK since the late 1960s, it is possible to identify a coherent national policy from the 1950s onwards (Table 2). The focus of this policy has, in general, been on improving the quality of life in towns and cities but, the means of achieving this improvement, and the challenges faced have changed significantly since the 1950s resulting in four distinct phases of urban policy. During each phase there have been policies and initiatives to tackle the problems of existing urban areas which, although present earlier, have been a major component of urban policy since the launch of the Urban Programme in the late 1960s (Couch and Dennemann, 2000; Samuel, 2006).

Table 2: The phases of urban policy (Adapted from Rydin, 2003)

Phase	Socio-economic change	Key planning activities	Regeneration policies and initiatives
Post-war consensus and the emergence of an urban policy (1950s and 1960s)	Post-war boom Mixed economy Consensus politics	New towns Post-war reconstruction	Slum clearance and new build Urban Programme
Crisis (1970s)	Turning point economic growth Urban-rural shift Inner city decline	Inner city policy Rehabilitation and conservation	Urban Programme Inner Area Programme
Thatcherism (1979 to the mid-1990s)	Recession and recovery Inner city riots New technology Collapse of mixed-economy consensus	Urban regeneration Countryside policy Flagship projects	Urban Development Corporations National Garden Festivals (Ch.5) Enterprise Zones Simplified Planning Zones City Challenge
The Third Way (1997 onwards)	Globalization of politics, economics and environmental change	European integration Global environmental crisis Rural crisis	Single Regeneration Budget English Partnerships Urban Regeneration Companies New Deal for Communities

Detailed reviews of urban regeneration policy exist within the literature so this will not be covered here. Of particular relevance to this work are the reviews of urban regeneration policy with a specific focus on physical regeneration reported by Parkinson (1989) and Imrie and Thomas (1999). Reviews of specific initiatives have also been reported (Lloyd and Black, 1993; Blackman, 1995; PACEC, 1995; Smith Morris, 1997; Brennan et al., 1998; Rhodes et al., 2003). From these reviews it can be seen that in the 1980s and 1990s, initiatives followed an evolutionary pattern with successful features being shared by successive policies and many focused on physical and property-led regeneration including brownfield regeneration.

During the 1980s market forces replaced political intervention as the primary response to urban decline and the control of regeneration was centralised (Parkinson, 1989). These changes were not reversed during the 1990s and the outcome was reduced public expenditure in urban areas and the arrival of new actors from the private and community sectors in the field of urban regeneration (Parkinson et al., 2006).

The current objective of urban policy is to create better towns and cities in England (DCLG, 2006k) and the current objectives of regeneration policy include:

Recognising cities as economic drivers;

Shifting the balance of power for regeneration from national to regional, local and neighbourhood actors;

Reducing sprawl and encouraging brownfield redevelopment; and

Developing sustainable communities (Parkinson et al., 2006).

The final two objectives are shared with the policy on sustainable development (ODPM, 2003b; HM Government, 2005) and urban regeneration policy can be considered to be contributing to the delivery of sustainable development in urban areas.

Within urban regeneration policy, brownfield redevelopment is considered to be a mechanism to deliver the regeneration of urban areas and, therefore, one of the objectives of urban brownfield redevelopment should be to contribute to the wider regeneration of the urban area in which it is located.

3.2.4 Brownfields First: The Development of a Sequential Approach to the Allocation of Land for Development

The emergence of the sustainable development and urban renaissance agendas, in the early and late 1990s respectively, led to a shift in residential development away from greenfield sites towards brownfield sites (Adams and Watkins, 2002; Tiesdell and Adams, 2004). This became part of planning policy in 1995 when the Conservative Government introduced a target to build half of all new homes on re-used sites by 2005 (DoE, 1995) and in 1998 the target was raised to 60% (DETR, 1998) (see Table 3).

Table 3: History of the target for new housing on PDL (Sources: Samworth, 1986; DoE, 1995; DoE, 1996; DETR, 1998; ODPM, 2003b; and 2005h; DCLG, 2006a)

Year	Action
1986	Secretary of State for the Environment (Kenneth Baker) states that as much development as possible should take place on derelict land to ease the pressure on greenfields
1995	Target introduced to build half of all new homes on re-used sites by 2005
1996	Housing 'Green paper' includes consultation on raising target to 60%
1998	Target raised to 60% of new homes to be built on PDL by 2008
2003	Target reconfirmed by the Sustainable Communities Plan
2005	Target reconfirmed and extended until 2010 by the ODPM's five year housing plan
2006	ODPM is replaced by DCLG who adopt the five year housing plan as part of their strategy to deliver sustainable communities

Changes within the planning system (Town and Country Planning Act, 1990; Planning and Compensation Act, 1991) and restrictions on greenfield land, led to a much greater emphasis on brownfield redevelopment (Tiesdell and Adams, 2004). In addition, a sequential test for the allocation of housing land was introduced which

considered brownfield sites for allocation for development before greenfield sites (see Table 4).

Table 4: History of the sequential test in planning policy (Sources: DoE, 1994; DETR, 1998; POST, 1998; Urban Task Force, 1999; DETR, 2000b)

1994	The assumption that Local Authorities should give priority to developments on vacant and under-used urban sites before releasing greenfield land introduced as part of the regional planning guidance for the Thames Gateway sub-region of South-East England
1998	Sequential test proposed as a national planning policy
1998	Government consults on how to develop a sequential approach to selecting land for housing and urban development
1999	Urban Task Force propose that a sequential approach to the release of land is formally adopted
2000	A sequential approach to the allocation of housing land is adopted as planning policy and includes the presumption that previously developed sites should be developed before greenfield sites

Therefore, the adoption of a target for the proportion of new homes on previously developed sites and the introduction of a brownfield-first sequential test have been key drivers for brownfield redevelopment for residential uses, and are key components of the current policy on brownfields in England.

3.2.5 Summary of Policy Objectives Related to Brownfield Redevelopment

As identified above, policy on derelict land, contaminated land, urban regeneration and the allocation of land within local plans have all had an influence on brownfield redevelopment policy and the relevant objectives of each policy is summarised in Table 5.

Table 5: Objectives of derelict land, contaminated land, urban regeneration and land allocation policy relevant to brownfields

Policy	Objectives
Derelict land (section 3.2.1)	Redevelopment should tackle the risks associated with derelict land Derelict land should be re-used to relieve pressure on the countryside and provide land for development in urban areas
Contaminated land (section 3.2.2)	Contaminated brownfield sites should be made suitable for the proposed use
Urban regeneration (section 3.2.3)	Brownfield redevelopment should contribute to urban regeneration
Land allocation (section 3.2.4)	60% of new dwellings should be provided on PDL PDL should be considered for development before greenfield sites

3.3 Brownfield Policy in England

The Government's policy is that PDL, which includes brownfields, should be reused to protect the countryside and regenerate urban areas (ODPM, 2003b; HM Government, 2005; ODPM, 2005h). The *Sustainable Communities Plan* in particular places emphasis on regenerating urban areas by making the best use of land including recycling PDL (ODPM, 2003b).

The specific objectives of the Government's policy on brownfields are:

To provide 60% of new dwellings on PDL (ODPM, 2005h);

To reduce the stock of PDL at a rate of over 1,100 hectares per annum by 2004 (reclaiming 5% of the 2001 stock of PDL[2] by 2004 and 17% by 2010);

For the Regional Development Agencies and English Partnerships to redevelop over 1,400 hectares of PDL per year (ODPM, 2003b), and;

To create a body (the Land Restoration Trust) to manage PDL that is only suitable for use as public open space (ODPM, 2003b).

[2] Based on a stock 66,000 hectares

The success of the policy is assessed by measuring, at a national level, the proportion of new dwellings built on PDL and the proportion of all development on PDL (Sustainable Development Unit, 2007).

3.3.1 Delivering the Government's Brownfield Policy

Since 1997, the key actions taken by the Government to meet its aim of re-using PDL have been to ensure planning policy promotes the re-use of PDL, to give English Partnerships a strategic role in delivering redevelopment, to create Regional Development Agencies, Urban Regeneration Companies and the Land Restoration Trust and to provide financial incentives for private sector redevelopment.

Planning policy is the primary mechanism for ensuring new developments are built on PDL. *Planning Policy Statement 1* (PPS1) sets out the principles of how sustainable development can be delivered through the planning system (ODPM, 2005c) and creates a framework for delivering it at both the regional and local planning levels through *Regional Spatial Strategies* and *Local Development Frameworks*. This ensures that the objectives of the *Sustainable Communities Plan* (ODPM, 2003b; 2005h) are incorporated into regional and local planning policy.

The Government's policy on housing, Planning Policy Statement 3 (PPS3), states that the priority for new development should be PDL, particularly where it is vacant or derelict, but it does not include any explicit mention of a sequential approach to the allocation of land for development (see section 3.2.4) (DCLG, 2006h). PPS3 creates a hierarchy of targets for the proportion of new dwellings on PDL at the regional and local level to contribute towards the national target. Local Authorities are required to develop housing implementation strategies that include measures on how the target will be met and actions that will be taken if the target is not being met. One suggested measure is that all planning applications on greenfield sites be rejected until it has

been demonstrated that the underperformance has been addressed. Therefore, despite not retaining the sequential approach to land allocation contained in earlier housing policy, PPS3 promotes the redevelopment of brownfield sites and provides local authorities the powers to ensure PDL is being redeveloped.

There are a number of other planning policy statements and guidance notes which cover a variety of areas relevant to brownfield redevelopment and these are discussed in chapter 4. These include planning for town centres (PPS6), sustainable development in rural areas (PPS7), biodiversity and geological conservation (PPS9), planning and pollution control (PPS23) and development on unstable land (PPG14).

English Partnerships is the national regeneration agency for England and was given a new strategic role of assembling land to deliver sustainable development by the *Sustainable Communities Plan* (ODPM, 2003b) further reinforced by the plan to deliver affordable housing (ODPM, 2005h). Between 2005 and 2008, it will invest £2.2 billion in:

Joint ventures with private partners;

Providing gap-funding to make projects viable for developers;

Delivering the redevelopment of sites, and;

Purchasing and disposing of sites (ODPM, 2005h).

It runs a number of brownfield regeneration programmes including the Hospital Sites Programme and the National Coalfields Programme which will redevelop 1,600 and 4,000 hectares of brownfield sites respectively (English Partnerships, 2006d; 2006f).

Regional Development Agencies (RDAs) were created for each of the eight regions and for London (Figure 3) to promote sustainable economic development in England (Regional Development Agencies Act, 1998)

Figure 3: Regional Development Agencies of England (Adapted from: Government Office for the South East, 2007)

The RDAs have five statutory aims (Regional Development Agencies Act, 1998):

1. To further the economic development and the regeneration of its region;
2. To promote business efficiency, investment and competitiveness;
3. To promote employment in the region;
4. To enhance the development and application of skills relevant to employment in the region , and;
5. To contribute to the achievement of sustainable development in the United Kingdom.

The role of the RDAs in brownfield regeneration is two-fold: to develop regional policies to contribute to the national brownfield policy objectives and to redevelop sites. The RDA are involved in developing strategies to deliver Government policies at a regional level including a *Regional Economic Strategy*, a *Regional Spatial*

Strategy and a *Regional Housing Strategy* (ODPM, 2005e; DTI, 2006). As part of this a regional target for the proportion of dwellings on PDL and a target for the amount of brownfield land to reclaim are established. These targets are used a part of the assessment of an RDAs performance and can be used to measure its contribution to delivering brownfield policy.

Local Authorities also have a dual role in delivering brownfield regeneration: a strategic role and a more direct role in redevelopment. They develop a *Local Development Framework* which outlines the spatial plan for the authority's area (ODPM, 2004e), allocates land for particular uses and can be used to bring forward brownfield land for redevelopment. By applying the sequential test (see section 2.3.2) Local Authorities play a key role in delivering the 60 percent target by allocating sufficient brownfield land for housing development. The more direct role of Local Authorities involves redeveloping sites, either alone or in partnership. The proportion of dwellings built on PDL is used as a measure of a Local Authorities performance (ODPM, 2005a) and can be used to measure its contribution to the delivery of brownfield policy.

The Land Restoration Trust (LRT) was created in 2004 by English Partnerships, the Environment Agency, Groundwork and the Forestry Commission to redevelop brownfield sites that are not considered to have commercial value (LRT, 2006). The LRT is not a mechanism for the delivery of the national PDL target as it redevelops sites as public open space so does not provide new dwellings on PDL. However, the LRT will contribute to tackling the legacy of brownfield land in England. This is achieved through the redevelopment of brownfield sites for open space by the original site owners, often with the LRT as a development partner. Subsequently ownership,

and a dowry for long-term management, is transferred to the LRT. The target is to restore and manage 1,500 hectares of PDL by 2007 and 10,000 hectares by 2014.

Urban Regeneration Companies (URCs) are public private bodies that have been set up to provide a dedicated agency for regeneration in urban areas where existing agencies, including Local Authorities, are not providing the desired driving force for economic and physical regeneration (ODPM, 2004h). They contribute to the delivery of brownfield regeneration by participating in joint ventures to redevelop sites, making site acquisitions for development schemes, acting as a catalyst for regeneration and attracting private sector investment (English Partnerships, 2004b). As such URCs are important in delivering brownfield redevelopment and regeneration in urban areas where other approaches have failed to do so.

To make brownfield sites more attractive to private developers there are incentives including gap-funding which provides public funds to cover the difference between the cost of redeveloping a site and the value of the redeveloped site. Between 2004 and 2008, £182 million worth of gap-funding has been made available for development for a known end-user, development for disposal on the open market and housing development (DETR, 2001; Hill, 2005; English Partnerships, 2006c; 2006e). Other incentives include tax credits for contaminated land remediation (worth £20 million in both 2004-05 and 2005-06) and stamp duty exemptions in disadvantaged areas (Finance Act, 2001; HMRC, 2006). However, there is some debate about their effectiveness as Oliver (2006) argues that tax incentives for remediating contaminated land have contributed to the increase in the proportion of new houses built on PDL whereas, in contrast, Thornton et al (2005) argue that, for many brownfield sites, the financial incentives available are insufficient to outweigh the costs of redevelopment.

3.4 A National Brownfield Strategy for England

The concept of a comprehensive national strategy for brownfield land in England, to be produced by English Partnerships, was introduced by the sustainable communities plan to identify how to best bring sites, especially long term derelict and vacant sites, back into use (Office of the Deputy Prime Minister (ODPM), 2003b). The first stage of the development of the strategy was a comprehensive study of the supply of brownfield land in England (see section 1.1 for the definition of brownfield adopted for this) (English Partnerships, 2003). This study also identified a variety of policy opportunities that could be considered in the development of a national strategy. Following the study, a joint ODPM and English Partnerships team, led by Paul Syms, was established to develop the strategy which was originally envisaged to be published in summer 2005 (English Partnerships, 2004a). However, this did not happen and it was not until late 2006 that outline proposals for a policy were published and consulted on (English Partnerships, 2006b). The proposed overarching principles of the strategy are:

> "When considering the allocation of land for future uses, the principle of 'redevelop first' shall be used alongside the PPS25 sequential test and reference to the site's potential biodiversity value in accordance with PPS9 and the accompanying publication Planning for Diversity and Geological Conservation: a Guide to Good Practice."
>
> "Delivery agencies should focus primarily on urban land in towns and cities that have the infrastructure capacity and suitability to support redevelopment."

"Full regard must always be taken of the environmental impact of undertaking remediation work, in compliance with legislative requirements."

"In situations where the cost of full remediation renders redevelopment of the site unsustainable, sufficient work should be carried out to safeguard the local environment and to remove visual blight."

"The highest design standards should be applied to all brownfield development, compatible with the economic limitations of the individual site."

The final stage of developing the brownfield strategy will be to present it to Ministers in early 2007, who will then consider how it relates to various policy matters (English Partnerships, 2006b).

If the principles and policies proposed in the brownfield strategy are adopted by the Government then it is unlikely that the objectives of brownfield policy in England will change but it could alter how the policy is delivered.

3.5 Measuring the Success of Brownfield Policy

To assess the success of brownfield policy in England the following will be addressed:

1. Are the targets set within the objectives for the policy (section 3.3) being met?
2. Has there been an increase in the amount of brownfield land being redeveloped?
3. Has there been a decrease in the amount of brownfield land?
4. Is the countryside being protected?
5. Are urban areas being regenerated?

The 60 percent target has been achieved every year since 2000 and in 2005 77% of new dwellings were built on PDL (Figure 4). The national target does mask regional differences: for example, in 2005, 95 percent of new homes were built on PDL in London whereas in the East Midlands, the only region that failed to meet the target, only 57 percent were (DCLG, 2006f).

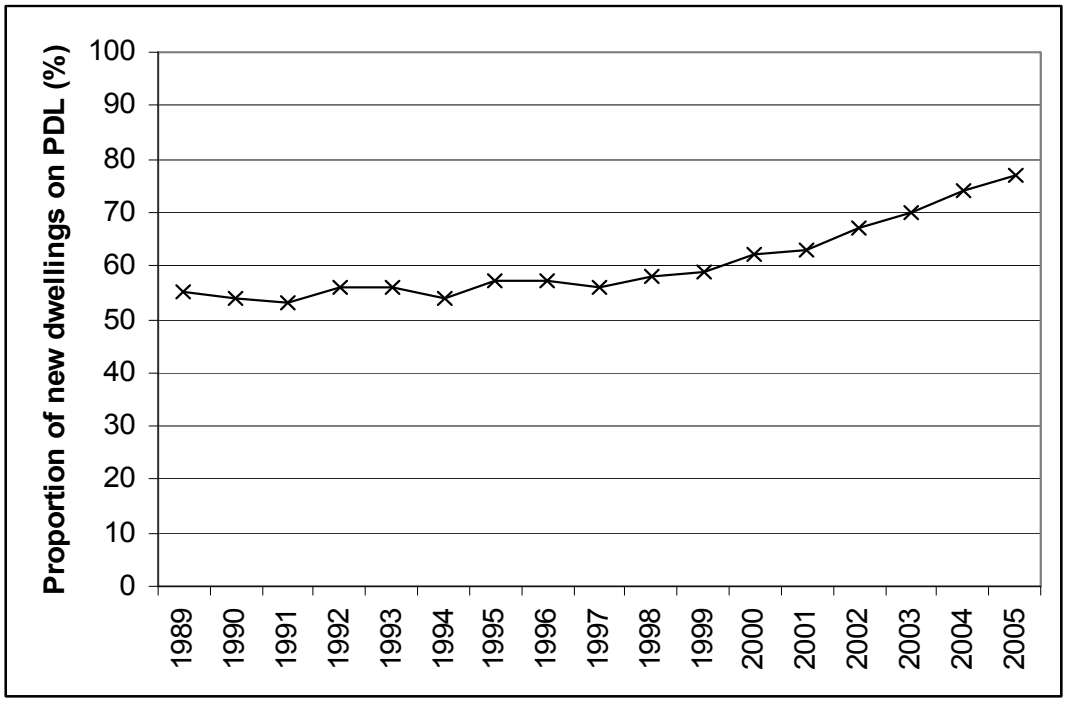


Figure 4: New dwellings on PDL, 1989 to 2005 (Data from: DTLR, 2001; DCLG, 2006; and 2007c)

The proportion of all development on PDL, has been showing an upward trend and in 2003 (the latest year for which figures are available) 62 per cent of all new development was on PDL (Figure 5).

These trends must be taken within the wider context which has seen an economic boom in the UK over the last decade or so. Whether these trends continue in less buoyant economic times will be a truer test of whether it is policy or the economy that is driving the increased re-use of previously developed land.

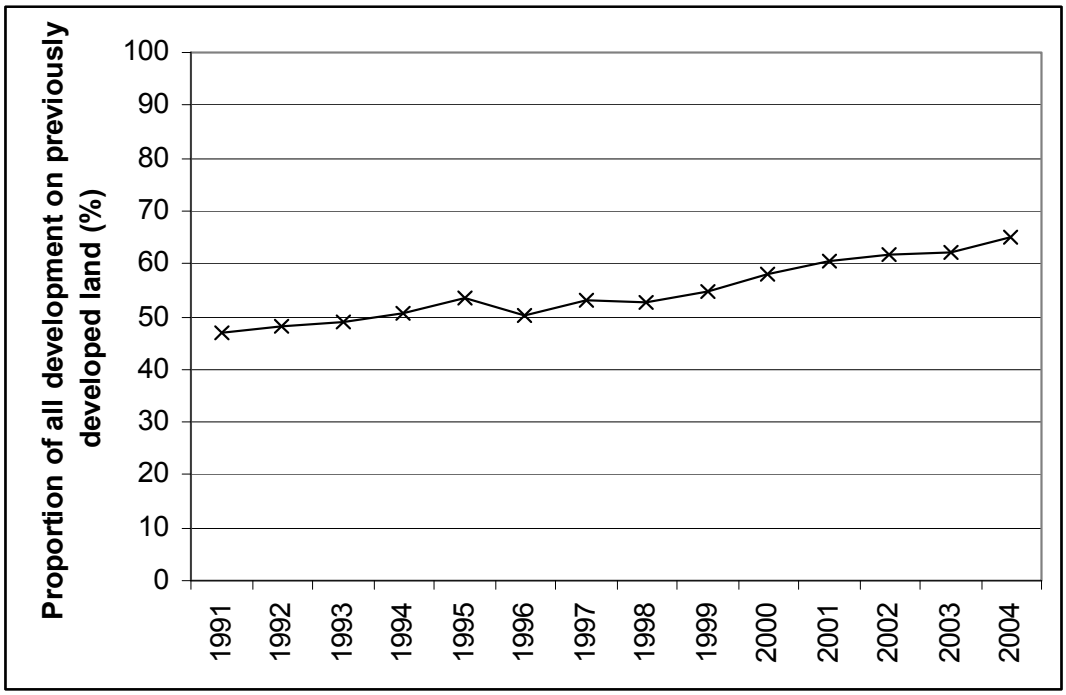


Figure 5: Development on PDL (Data from: ODPM, 2004d; and 2005d; DCLG, 2006e)

The target to reclaim PDL at a rate of over 1,100 hectares per annum was only achieved between 2003 and 2004 (Figure 6). However, the failure to meet this target is not as straight forward as it seems. There was no net reduction in total PDL until 2003 not because land was not being redeveloped but because of an increase in the amount of in-use PDL (i.e. land in use that is considered to have potential for redevelopment). This rise in the amount of in-use PDL has meant that the target to reclaiming 5% of the stock of PDL by 2004 was not achieved (Figure 7). However by 2004, nearly 8% of the 2001 stock of derelict and vacant land had been reclaimed and by 2005 over 12% had been reclaimed.

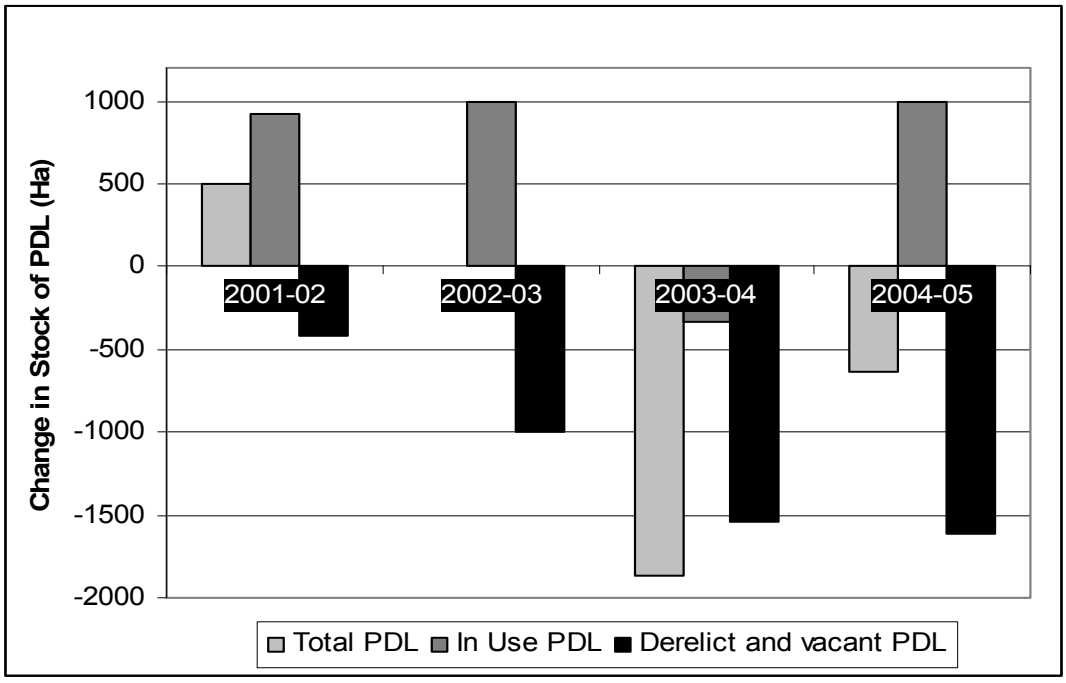


Figure 6: Net annual change in stock of PDL between 2001 and 2005 (Data from ODPM, 2002; 2003a; 2004g; and 2005g; DCLG, 2006j)

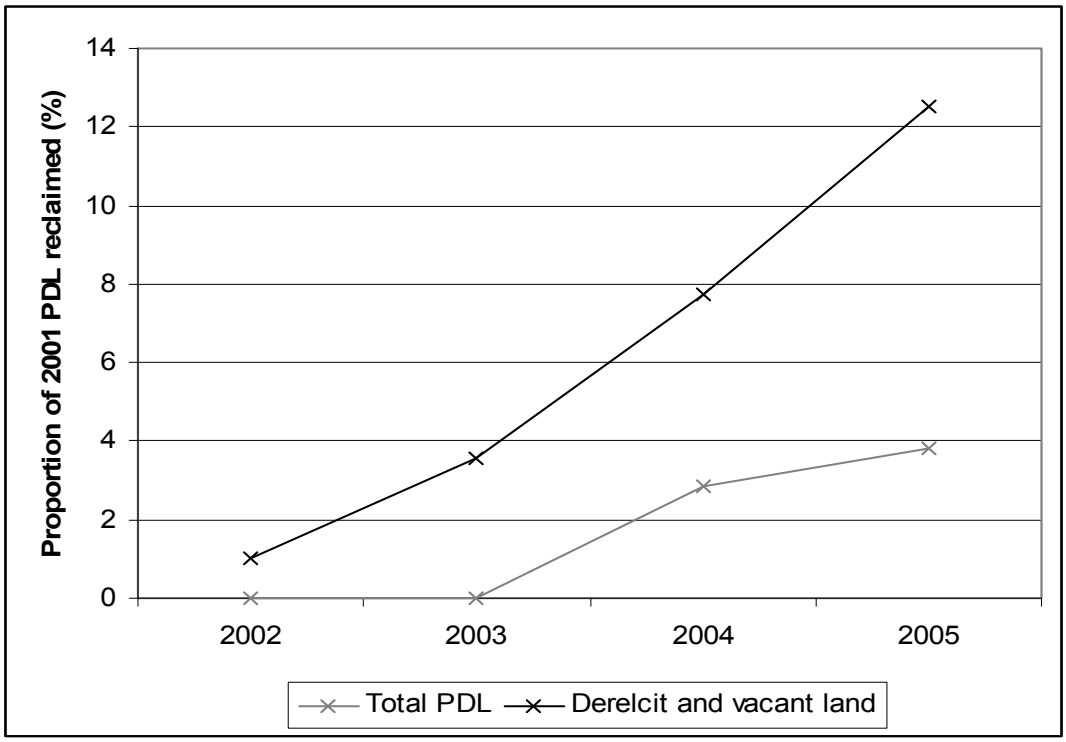


Figure 7: Cumulative proportion of 2001 stock of PDL reclaimed by year (Data from ODPM, 2002; 2003a; 2004g; and 2005g; DCLG, 2006j)

The target for the Regional Development Agencies and English Partnerships to reclaim 1400 hectares of PDL per year has been achieved in only two out of the last four years but on average it has been achieved over this time (Figure 8). As of

September 2006, the Land Restoration Trust owns and is managing 440 hectares of PDL and has arrangements to take over management of a further 156 hectares (Land Restoration Trust, 2006). The LRT still has someway to go to meet its target of restoring and managing 10,000 hectares of PDL by 2010 but as it has been offered over 20,000 hectares this seems likely to be achieved (Land Restoration Trust, 2005).

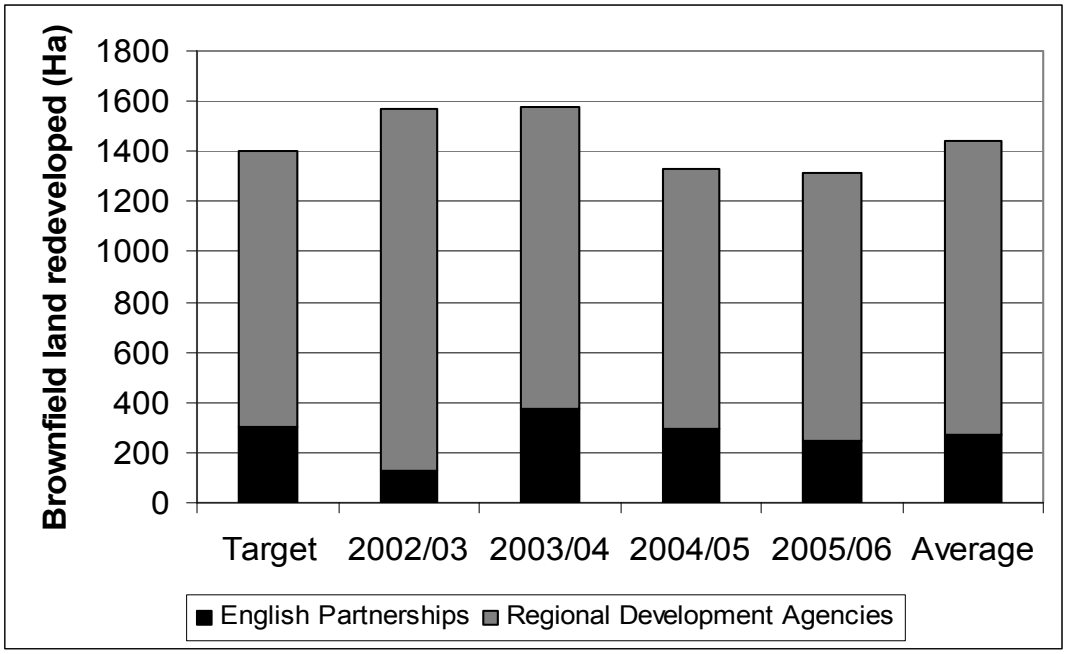


Figure 8: Brownfield land redeveloped by English Partnerships and Regional Development Agencies (Data from: dti and English Partnerships)

The amount of land used for development each year between 1994 and 2002 shows no clear trend but the amount of derelict land changing to developed uses was lower in 2002 then in any other year in this period. This indicates that the Government policy of focusing developing new development on PDL is not successfully increasing the amount of vacant and derelict land being redeveloped for hard-end uses (Figure 9 - N.B. data not available for 1999). Due to the time delay in the availability of data used to create Figure 9 (four years), it is not yet known how much land of each type has changed to developed uses since 2002.

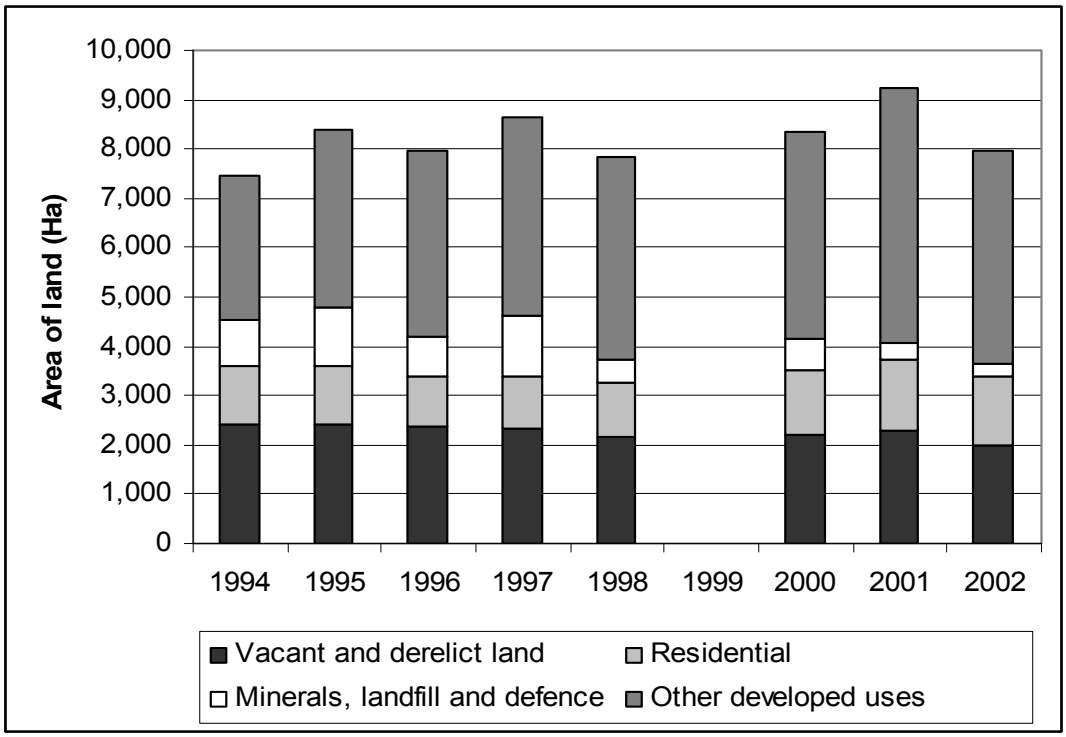


Figure 9: Land changing to developed uses by previous use, 1994-2002 (Data from: ODPM, 2005d; DCLG, 2006e)

There is evidence to suggest that the stock of PDL available for development is decreasing. The amount of vacant and derelict land has decreased each year since 2001 and the total amount of PDL recorded in the National Land Use Database has decreased each year since 2003 (Figure 10). Early indications are that these trends are set to continue for 2006 (Syms, 2006).

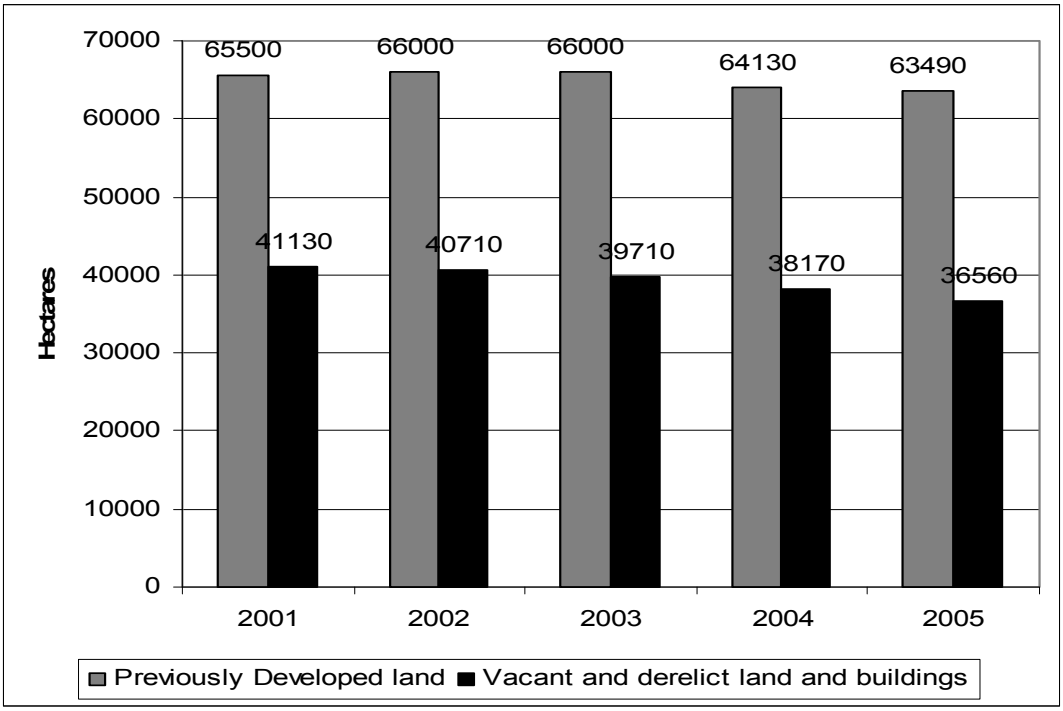


Figure 10: PDL in England 2001-2005 (Data from ODPM, 2002; 2003a; 2004g; and 2005g; DCLG, 2006j)

There is evidence to suggest that the countryside is being protected as there has been a reduction in the amount of rural land being consumed for development from over 7000 hectares in 1996 to just over 4000 in 2002 (Figure 11 – N.B. 1999 data is not considered to be accurate so has not been made available by the ODPM or DCLG)).

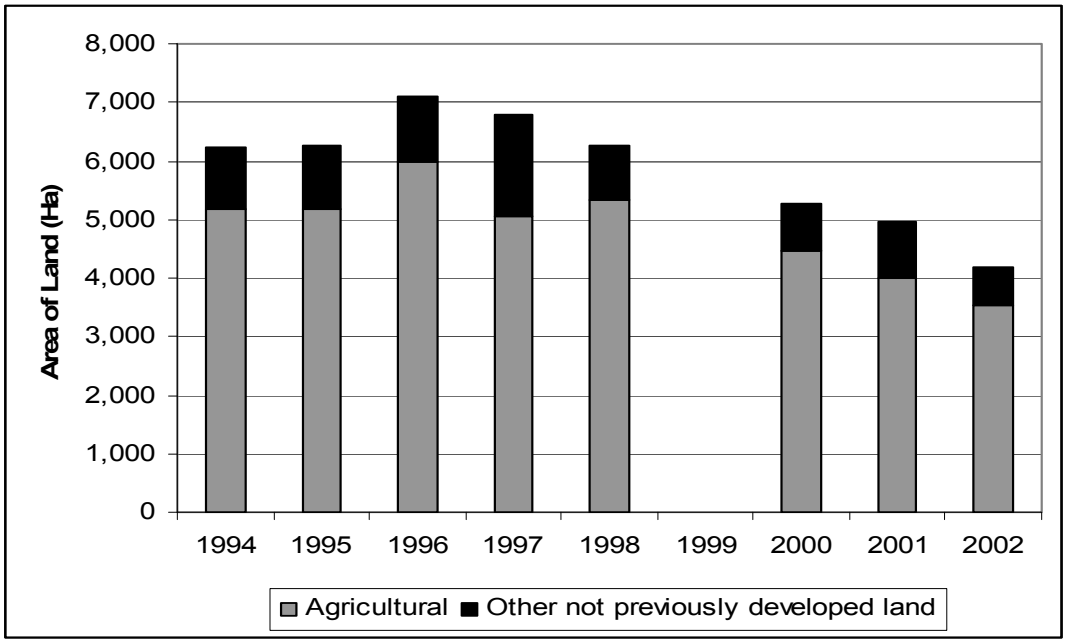


Figure 11: Rural land consumed for development, 1994-2001 (Data from: ODPM, 2005d; DCLG, 2006e)

Further evidence is provided by the reduction in the amount of non-PDL consumed for housing between 1995 and 2005 (). Between 1995 and 2001, this was matched by a decline in the number of dwellings completed but this trend was reversed after 2001 (Figure 13). In 2005 there was a slight increase in the total area of land consumed for new dwellings but the amount of non-PDL continued to decrease. The decrease in the amount of land consumed by an increasing number of new dwellings has been possible due to a dramatic increase in the density of new development (Figure 14).

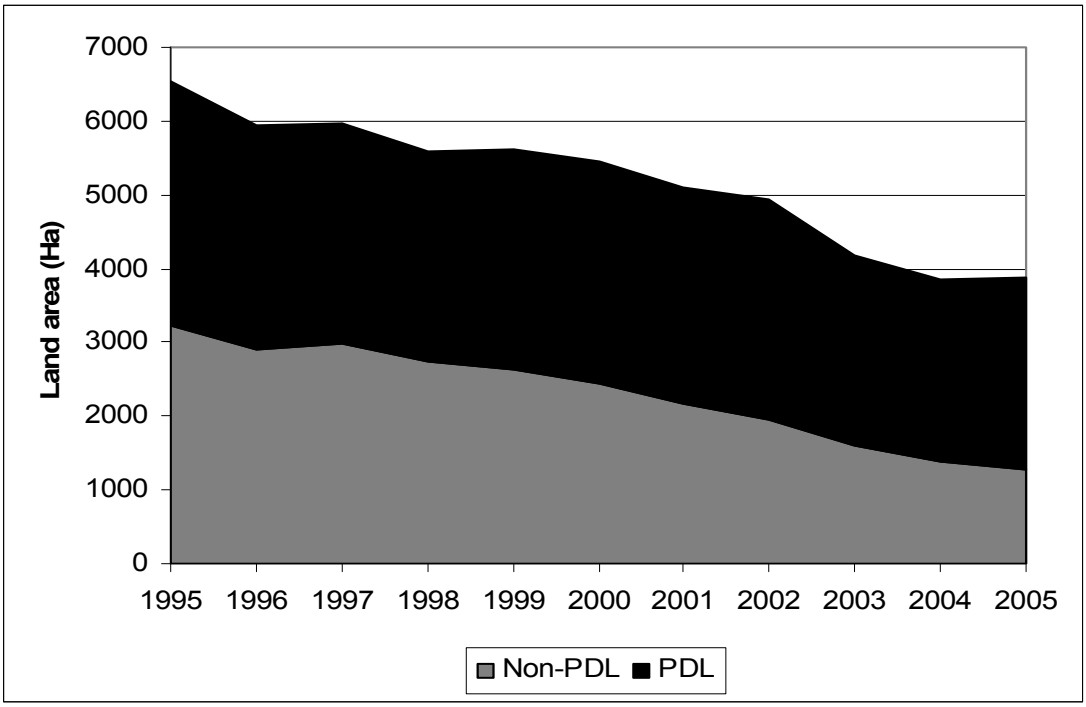


Figure 12: Land consumed for housing development, 1995 - 2005. Land area consumed calculated using dwellings completed per year from housing statistics and density of dwellings built from Land Use Change Statistics (Data from DCLG, 2006e; 2006g; and 2007b)

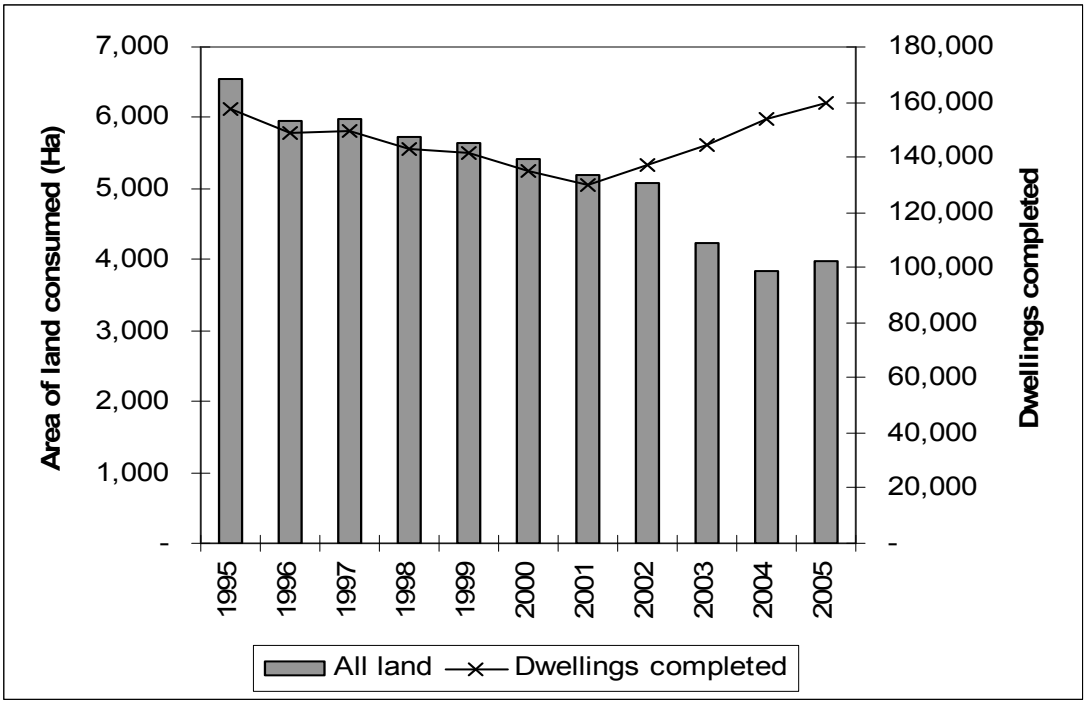


Figure 13: Dwellings completed and area of land consumed for new dwellings, 1995 – 2005. Land area consumed calculated using dwellings completed per year from Housing Statistics and density of dwellings built from Land Use Change Statistics (Data from DCLG, 2006e; 2006g; and 2007b)

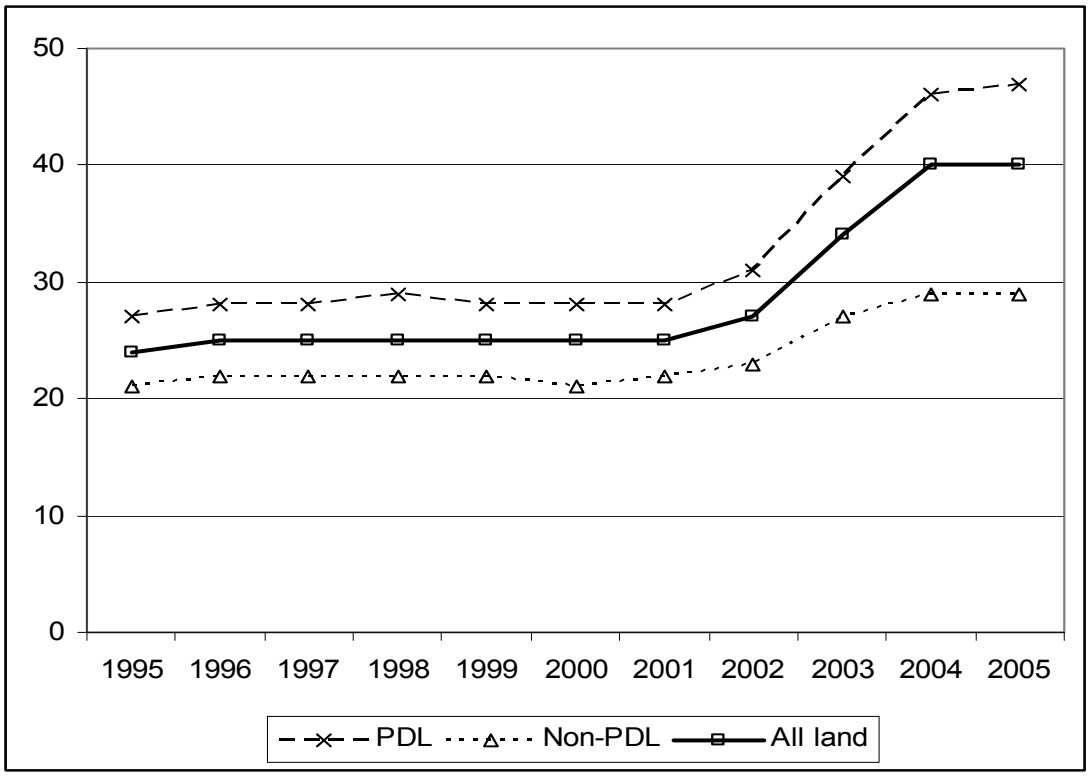


Figure 14: Density of new dwellings 1995-2005 (DCLG, 2006g)

It is not easy to assess if urban areas are being regenerated but a recent report found that there are signs of recovery in many cities particularly in economic and social

performance (Parkinson et al., 2006). The report concludes that the years of decline are over, which supports Government claims that England is experiencing an urban renaissance (Prescott, 2006).

3.5.1 Brownfield Policy in England and the A-B-C Model

Another way the policy can be assessed is to determine if it makes provisions for the redevelopment of all types of brownfield site. English Partnerships (2003) and CABERNET (2006) identify that brownfield sites can be categorised by land value after reclamation and redevelopment cost (Figure 15). A-sites are those sites that where the cost of redevelopment is less than the land value after redevelopment (i.e. those that are commercially viable for redevelopment), B-sites are those where the cost of redevelopment is similar to the land value after redevelopment (i.e. those that are at best marginally viable) and C-sites are those where redevelopment costs exceed the land value after redevelopment (i.e. those that are not commercially viable). There is a further category of site not identified in the model, which for continuity will be referred to as D-sites: those sites where, after considering long-term management costs, the land value after redevelopment is negative. These are likely only to be developed when there is also a means to subsidise the management of the redeveloped site.

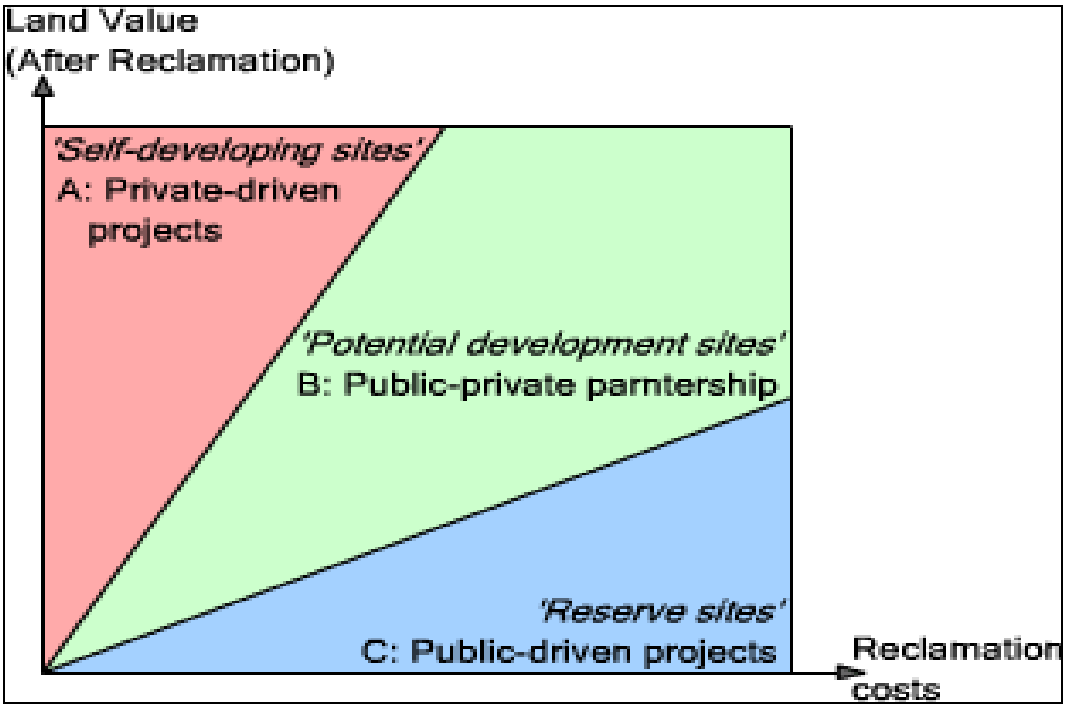


Figure 15: The A-B-C model of brownfield sites (CABERNET, 2006)

Redevelopment of A-sites is promoted by the general support for brownfield redevelopment within the English planning system and also by financial incentives, as they are available irrespective of whether the site requires incentives or not. B-sites generally require some form of public subsidy to be redeveloped and the available tax incentives will contribute to the redevelopment of some B-sites, as they reduce the cost of redevelopment, thus making the redevelopment of the site commercially viable. Gap-funding, that bridges the gap between the cost of redevelopment and the value of the land after redevelopment, is available for housing development from English Partnerships and for general development from the regional development agencies. C-sites require a greater level of public subsidy if they are to be redeveloped and as such tax incentives alone are unlikely to be sufficient and gap-funding is one method of ensuring they are redeveloped. Alternatively public bodies may become directly involved in the redevelopment of such sites, either alone or in partnership with the private-sector. In England this involvement is most likely to be though English Partnerships, Regional Development Agencies, Local Authorities or through

Urban Regeneration Companies. D-sites are likely to require public-sector redevelopment which may be carried out by the bodies outlined above. In addition to these, the Land Restoration Trust has been established specifically to redevelop sites that are considered to have no commercial value in order to create open space. Overall, brownfield redevelopment policy in England provides measures and actions for the redevelopment of each of the four categories of brownfield sites. However, it has not been possibly to carry out an analysis to determine if these measures and actions are actually ensuring each of these different types of brownfield sites are being redeveloped.

3.5.2 Of Cabbages and Chocolate: Problems with the Government's Brownfield Definition and Other Flaws in the Measurement of the Success of Brownfield Policy

The statistics used to measure the success of the re-use of PDL do not reflect brownfield redevelopment, although this is often claimed by the Government. The primary measure of the success of the policy, the proportion of new dwellings provided on PDL, does not relate to the amount of brownfield land that is redeveloped. Taking a very extreme example, if only one house was built in a year but it happened to be on a brownfield site, the Government measures would show that the policy had met its target of providing 60% of new homes on PDL. Using the proportion of new homes also takes no account of how much land each house is built upon, therefore the target could be achieved without reducing the consumption of greenfield sites if dwellings are built at high density on brownfield land and low density on greenfield sites. Although some of the targets within the policy relate to the amount of land redeveloped, they provide a poor measure of the actual success of the policy in terms of redeveloping brownfield sites as they are based on the definition for

PDL which does not require land to be derelict, vacant or underused (see section 1.2). For example, if a dwelling is built within the garden of an existing dwelling it will be contribute to the achievement of the Government target on the redevelopment of brownfield land.

Recently there has been much debate in Parliament about the Government definition and one MP even described the effects of defining gardens as PDL as being like asking a child to choose between cabbage and chocolate (presumably cabbage representing brownfields and chocolate representing gardens):

> "Dealing with developers is a bit like offering a child the choice between chocolate and cabbage - they may know that the cabbage is, in theory, good for them, but they will choose the chocolate every time." (Burt, 2006)

A number of solutions to these shortcomings will now be suggested. Firstly, it would be a more appropriate to use the proportion of land used for all new development and for residential development that was PDL than the proportion of new dwellings on PDL. Secondly, the reported figures could be broken down by the previous use of the land, such as residential land, vacant and derelict land, minerals and defence land and land used for other developed uses, to provide more detail of the previous use of land. Producing such measures of brownfield redevelopment policy would not be problematic as the information required to produce them is already collected and published by the Government as part of the Land Use Change Statistics. However, if the proportion of land used for new dwellings that was previously derelict or vacant was used as indicator to measure the success of brownfield redevelopment policy (i.e. the measure that best fits the definition of brownfield used in this thesis) the Government's claims of increasing brownfield redevelopment would be undermined as it has remained stable at between 21% and 24% between 1997 and 2005 (Table 4 of

DCLG, 2006f) and the amount of vacant and derelict land redeveloped each year has decreased period between 1994 and 2002 (see Figure 9).Therefore the proportion of new dwellings on PDL provides a poor measure of how successful the policy on the redevelopment of PDL is at redeveloping brownfield sites. Measuring the success of the policy in terms of the proportion of new dwellings that are built on PDL provides a poor measure of the redevelopment of brownfield sites as defined by CABERNET. A better measure would be to use the proportion of land used for all new development and residential development that was PDL (as defined by the Government) or to provide a break down of either the proportion of dwellings built, or proportion of land used, based on the previous use of the land, for example:

Greenfield or non-PDL;

Residential land;

Vacant and derelict land;

Minerals land and defence land, and;

Other developed uses

This information is already collected by the DCLG as part of the Land use change statistics but if it were used to measure the success of brownfield policy Government claims that brownfield redevelopment is increasing would be undermined.

3.6 Summary

Brownfield policy in England is to re-use PDL, including brownfields, to protect the countryside and to regenerate urban areas. Brownfield policy emerged from policies on derelict land, contaminated land, urban regeneration and sustainable development and is delivered through planning policy and a number of public (or semi-public) bodies, primarily English Partnerships, Regional Development Agencies, Local Authorities, Urban Regeneration Agencies and the Land Restoration Trust. This

chapter has highlighted that the Government's policy on brownfields is meeting most of its targets and is contributing to the protection of the countryside. However, it remains unclear how the policy has contributed to the regeneration of urban areas. This thesis will explore how the redevelopment of brownfield sites impacts urban areas and how redevelopment can best contribute to the regeneration. Before doing this, it is important to recognise that, although policy is a top-down process, the increasing focus on brownfield regeneration can only be delivered by redeveloping individual sites, which is the focus of the next chapter.

Chapter 4: Towards a Brownfield Redevelopment Roadmap

Redeveloping a brownfield is a complex multi-dimensional process that can tackle environmental, social and economic problems in post-industrial urban areas (Environment Agency, 2003; RESCUE, 2005). Failure to appreciate this complexity can delay or even prevent the return of sites to beneficial uses which in can turn mean that the opportunity to regenerate urban areas is lost (RESCUE, 2005).

This chapter moves away from the objectives of brownfield policy and focuses on the redevelopment of brownfield sites, presented as a roadmap of the redevelopment process. As the process will differ for each brownfield site the roadmap map represents the key stages and activities of the process that are likely to be part of redeveloping any brownfield site. The roadmap was developed to provide an understanding, and representation, of where policy and information can influence the redevelopment of brownfield sites. This will inform the evaluation, modelling and analysis carried out in this thesis. In addition it will be used to generate a list of the components and properties of brownfield sites and a list of the mechanisms of brownfield redevelopment, and where appropriate brownfield regeneration, that is required for Brownfield REMIT/RESPONSE (see chapter 6).

The roadmap developed in this research is included electronically on a CD accompanying this thesis. The roadmap was compiled by reviewing existing roadmaps of the redevelopment process and augmenting these with further detail of the specific processes involved in redeveloping a brownfield site This development of this roadmap helped the author develop a good understanding of the brownfield redevelopment process and it is hoped that by making this available it may help others

learn more about the redevelopment process. This roadmap should be treated as a work in progress as it will always be under review and the author hopes to continue developing this and make it more widely available in the future. Within this chapter extracts and simplified versions of parts of the roadmap are presented to explain the brownfield redevelopment process.

4.1 The Use of Roadmaps to Describe Brownfield Redevelopment

A roadmap should outline the stages, options and decision points of a process in order to provide a start to finish guide and can vary from simple descriptions to interactive computer programmes. Roadmaps have been used in a wide range of fields and can be used to analyse processes that have already occurred or can guide a process, as in the roadmap for peace in the Middle East developed by the United States Government (Bureau of Public Affairs, 2003).

There are at least four brownfield roadmaps within the literature:

The Brownfield Guide: A practitioner's guide to land reuse in England[3] (English Partnerships, 2006a);

Brownfield: managing the development of PDL: a client's guide (Laidler et al., 2002);

Roadmap of a holistic Brownfield Regeneration project (RESCUE, 2005), and;

Chart of the Brownfields Redevelopment Process Flow (USEPA, 2001).

[3] English Partnership's roadmap was published after the initial writing of this chapter so was included for completeness but it was not possible to incorporate a diagram showing this roadmap

English Partnerships' (2006a) and Laidler et al's (2002) roadmaps (Figure 16) provide guidance for those managing the development process (i.e. developers) in the UK. Laidler et al's roadmap represents the process of brownfield redevelopment (rather than brownfield regeneration) and focuses on the process of redeveloping land as a construction project, rather than as part of wider urban regeneration. As such it emphasises the physical and environmental aspects of the process and provides little information about the policy and social aspects of brownfield redevelopment. English Partnerships' roadmap places greater emphasis on the role of redevelopment in regeneration and is intended to provide guidance for public-sector, private sector or community-led redevelopment. English Partnerships' roadmap places significantly greater emphasis on the selection and assessment of redevelopment options than Laidler et al's roadmap but does not provide any specific tool or method to select the preferred brownfield redevelopment option. The difference between the two roadmaps is explained, in part at least, by their purpose. Laidler et al's roadmap was published by the Construction Industry Research and Information Association (CIRIA) as guidance for land owners, developers, investors, Local Authority contaminated land and planning officers and environmental and engineering consultants. English Partnerships' roadmap was developed as part a national brownfield strategy for England (see section 3.4) and is intended to provide guidance for a wider selection of stakeholders on effectively and sensitively reusing brownfield land (Laidler et al., 2002; English Partnerships, 2006a).

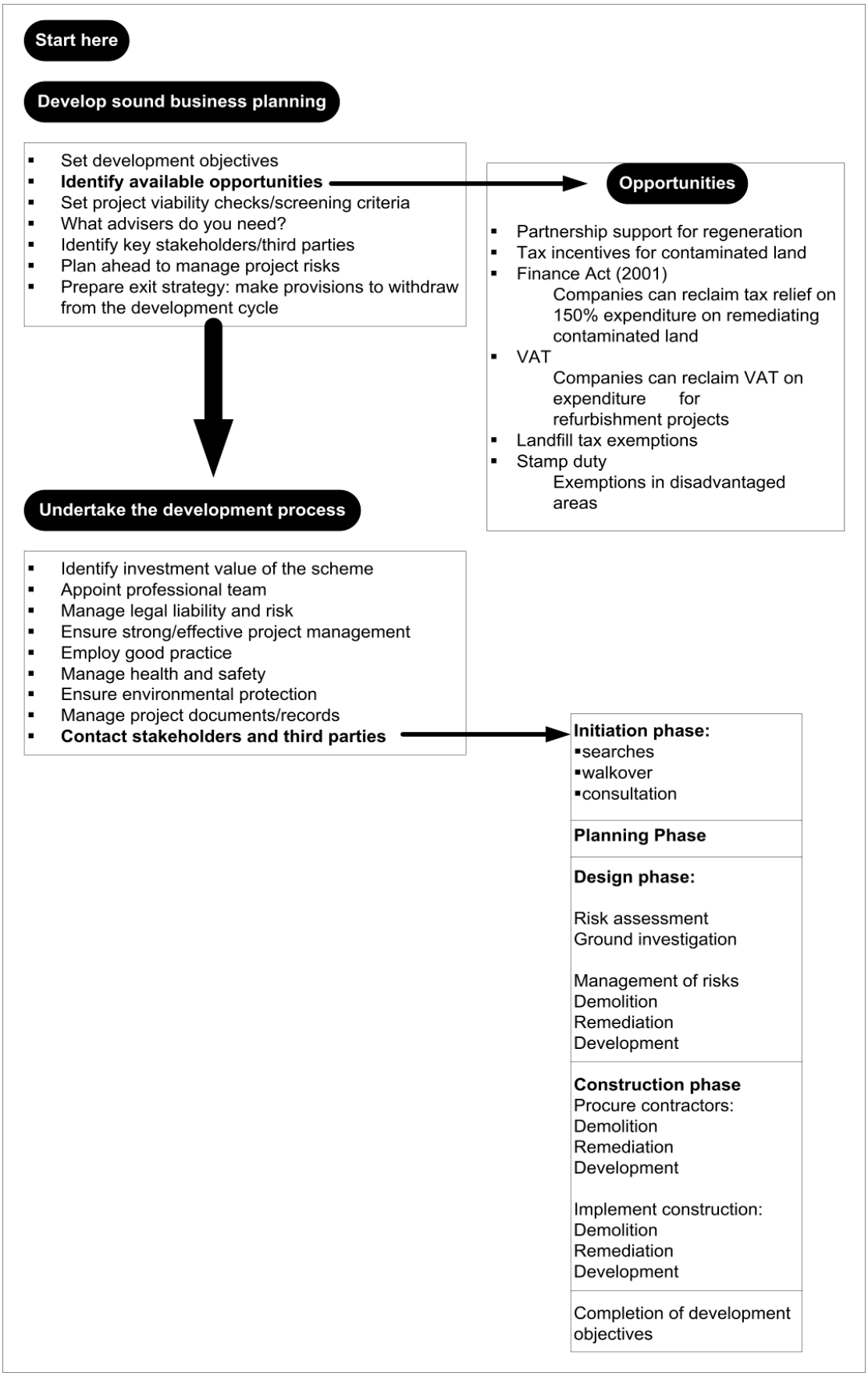


Figure 16: Roadmap of the development of PDL (Adapted from Laidler et al., 2002)

The ‘roadmap of a holistic brownfield regeneration project’ (Figure 17) presents the planning, land quality and citizen participation aspects of the process as they should be carried out to deliver ‘sustainable brownfield regeneration’ (RESCUE, 2005) and as such it can be considered to be guidance on how brownfield redevelopment can sustainably contribute to urban regeneration. As this roadmap is intended as best practice guidance, in some respects it presents an idealised situation rather than representing the situation as it occurs, particularly in respect of citizen participation.

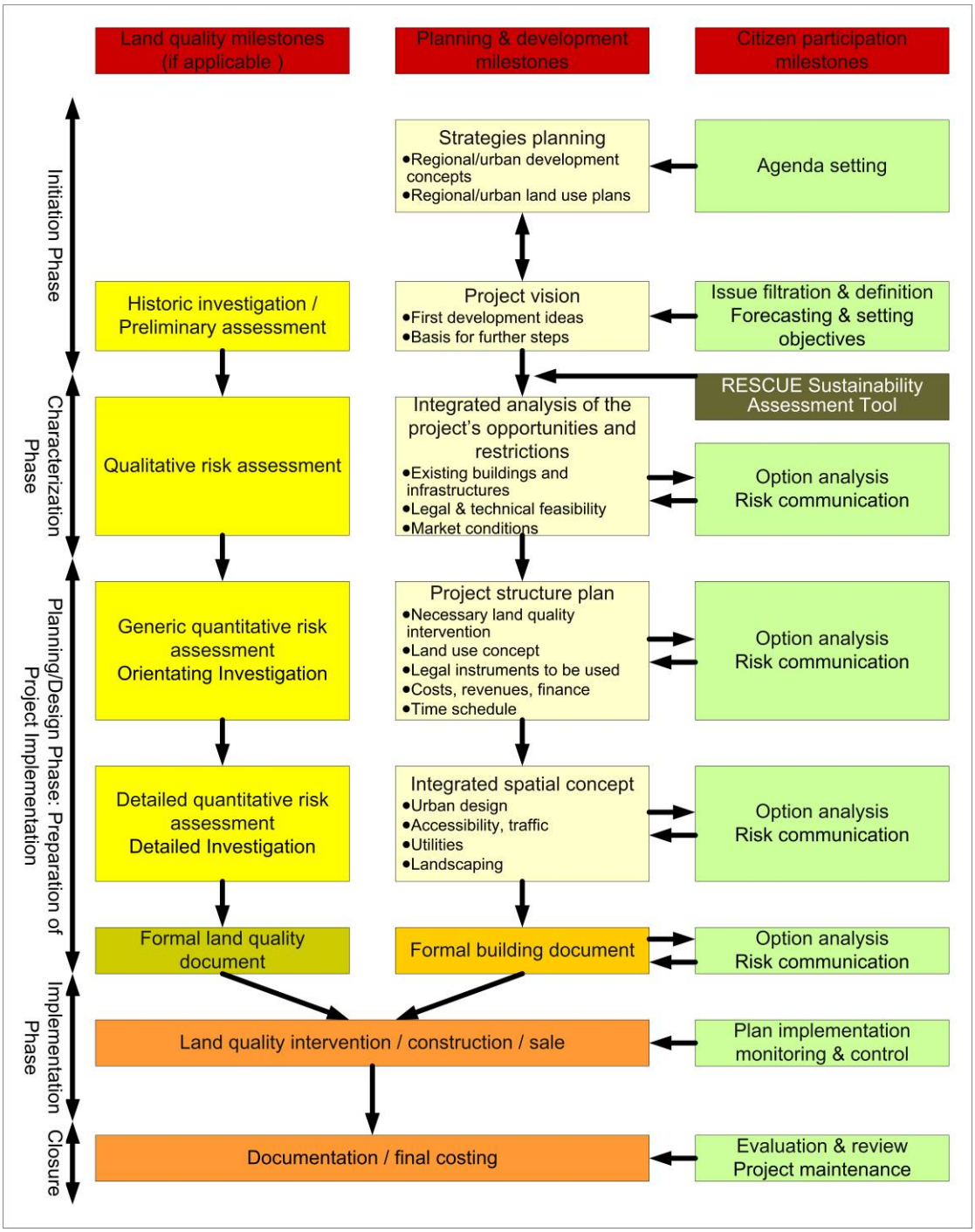


Figure 17: Roadmap of a holistic Brownfield Regeneration project (Adapted from RESCUE, 2005)

In the United States a brownfield site is always considered to be affected by contamination[4] and as such the USEPA Roadmap (USEPA, 2001) (Figure 18) focuses

[4] In US a brownfield site is "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant

on contaminated land management and is similar to the UK framework for the management of land contamination (Defra and Environment Agency, 2004). This roadmap provides a guide to the process of managing a particular components of the redevelopment process and provides an example of the type of roadmap that will be incorporated with in the roadmap developed in this research.

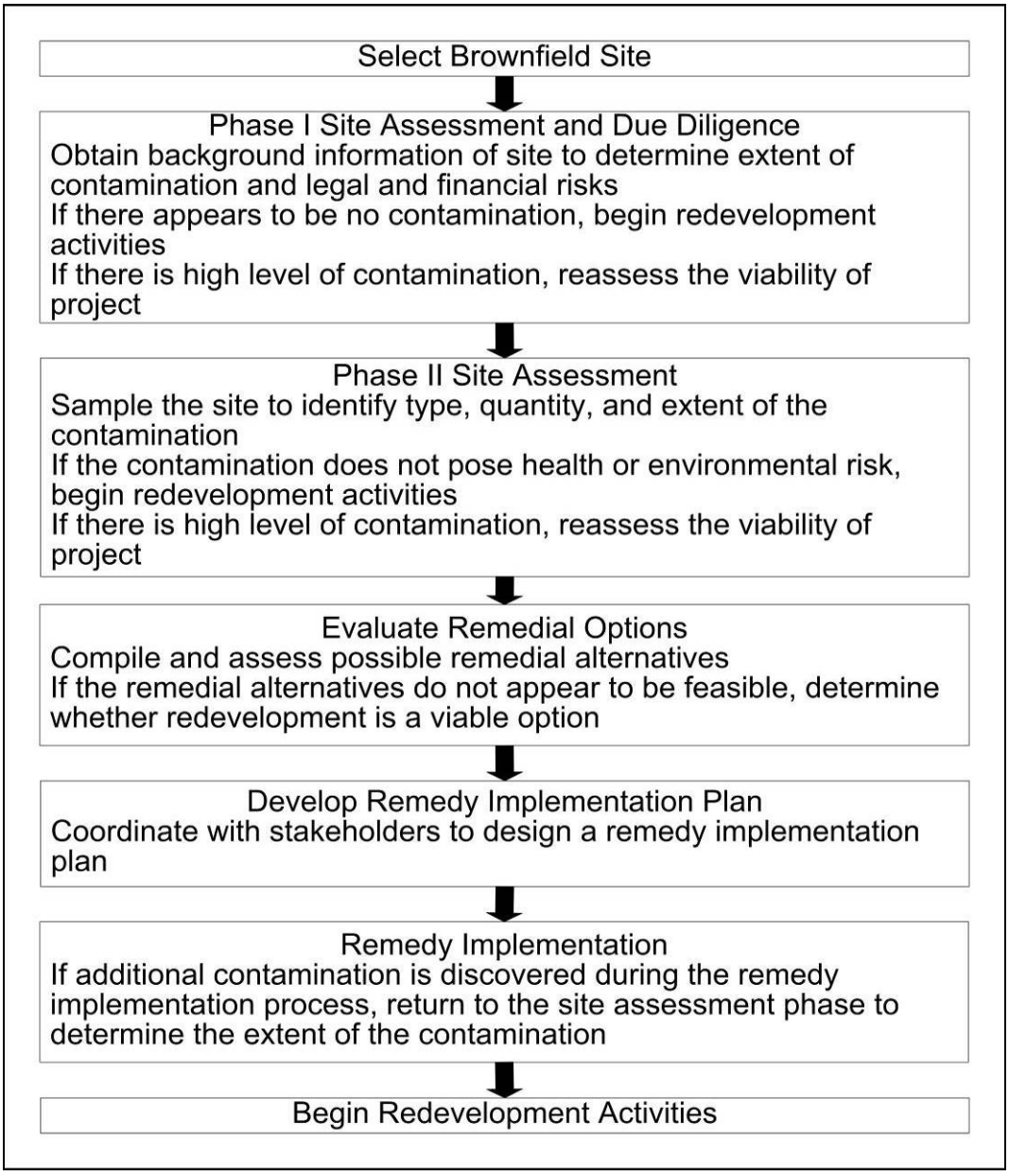


Figure 18: US EPA Chart of the Brownfields[5] Redevelopment Process Flow (Adapted from USEPA, 2001)

Although roadmaps exist, none provide a start to finish guide of the process that outlines the stages, options and decision points from the perspective of multiple stakeholders in sufficient detail to develop a list of brownfield characteristics and the mechanisms of brownfield redevelopment and regeneration. The research presented here is intended to build upon existing roadmaps by considering the process from a wider perspective and incorporating more detail about the stages, components and decisions of brownfield redevelopment.

4.2 The Process of Redeveloping Brownfield Sites

4.2.1 Overview of the Brownfield Redevelopment process

A large body of urban and property development literature exists including a number of texts which provide a broad overview of the development process for example Harvey (2000), Cadman and Topping (1995) and Issac (1996). From these it is clear that development projects, including those on brownfield sites, have four main stages (Figure 19):

1. Initiation;
2. Characterisation, planning and design;
3. Implementation; and
4. Completion.

Havard (2002) identifies that there are two starting points for the development process:

1. A site has been identified and a new use for it is required, or;
2. There is a demand for a new use and a site is required to meet this demand.

Each of the broad overviews of the development process takes the latter as their starting point. However, in the case of brownfield redevelopment the former is the case and will be taken as the starting point for redevelopment.

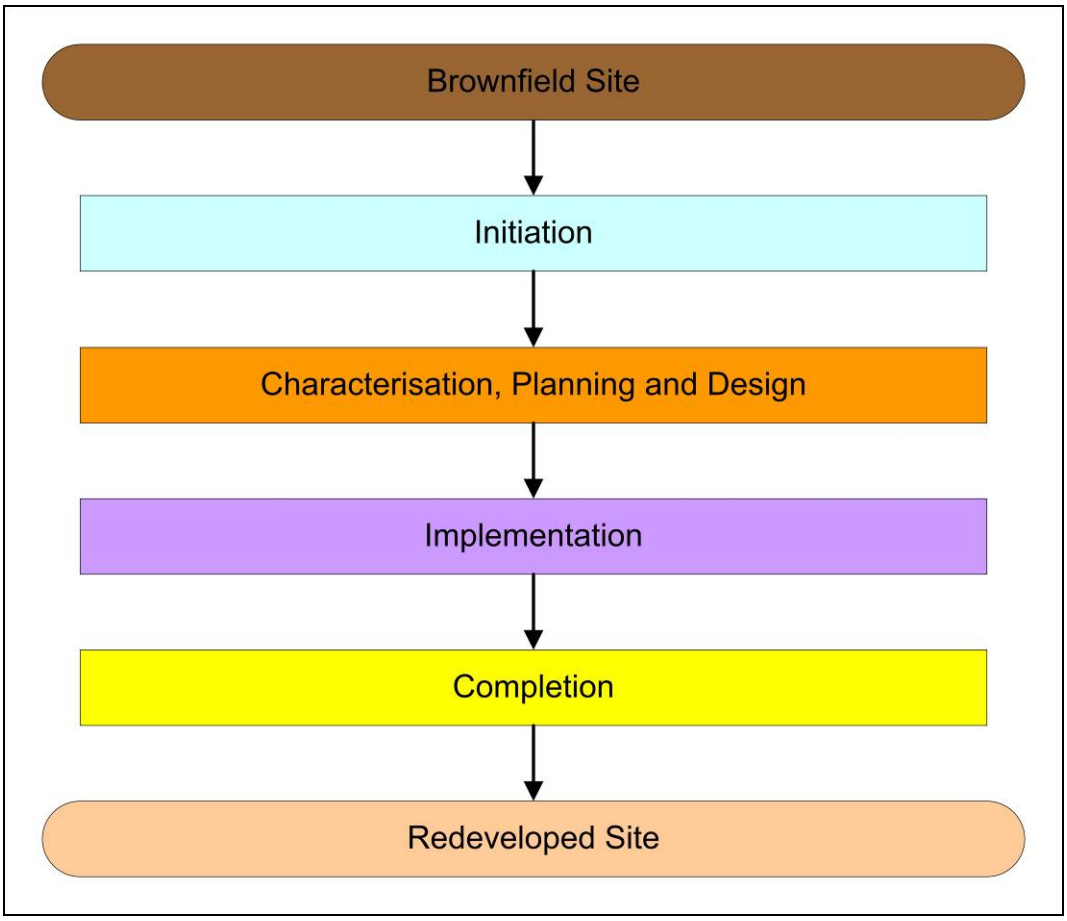


Figure 19: Conceptual model of brownfield redevelopment including the key stages

Within each stage there are processes that need to be carried out and decisions that must be taken. To facilitate these decisions information is required and the most information intensive stages are initiation and characterisation, planning and design.

The boundary between the stages is not always clear but each stage can be said to be complete upon reaching a key milestone or set of milestones within the process, which is when the next stage of the process can begin. However, due to the complex nature of brownfield redevelopment different aspects of the process may be at different stages at any given time. In addition, although the roadmap is presented in a generally linear form in reality the process is more iterative, as the process may return to earlier

stages as further information is discovered or new conditions come to light. For example during the implementation stage unexpected underground voids may be discovered forcing the process to return to characterisation, planning and design to make alterations in light of the new discovery. Processes within each stage may also be iterative, for example the design of a building may have to be altered to gain planning permission or meet planning conditions.

4.2.2 Initiation Stage of Brownfield Redevelopment

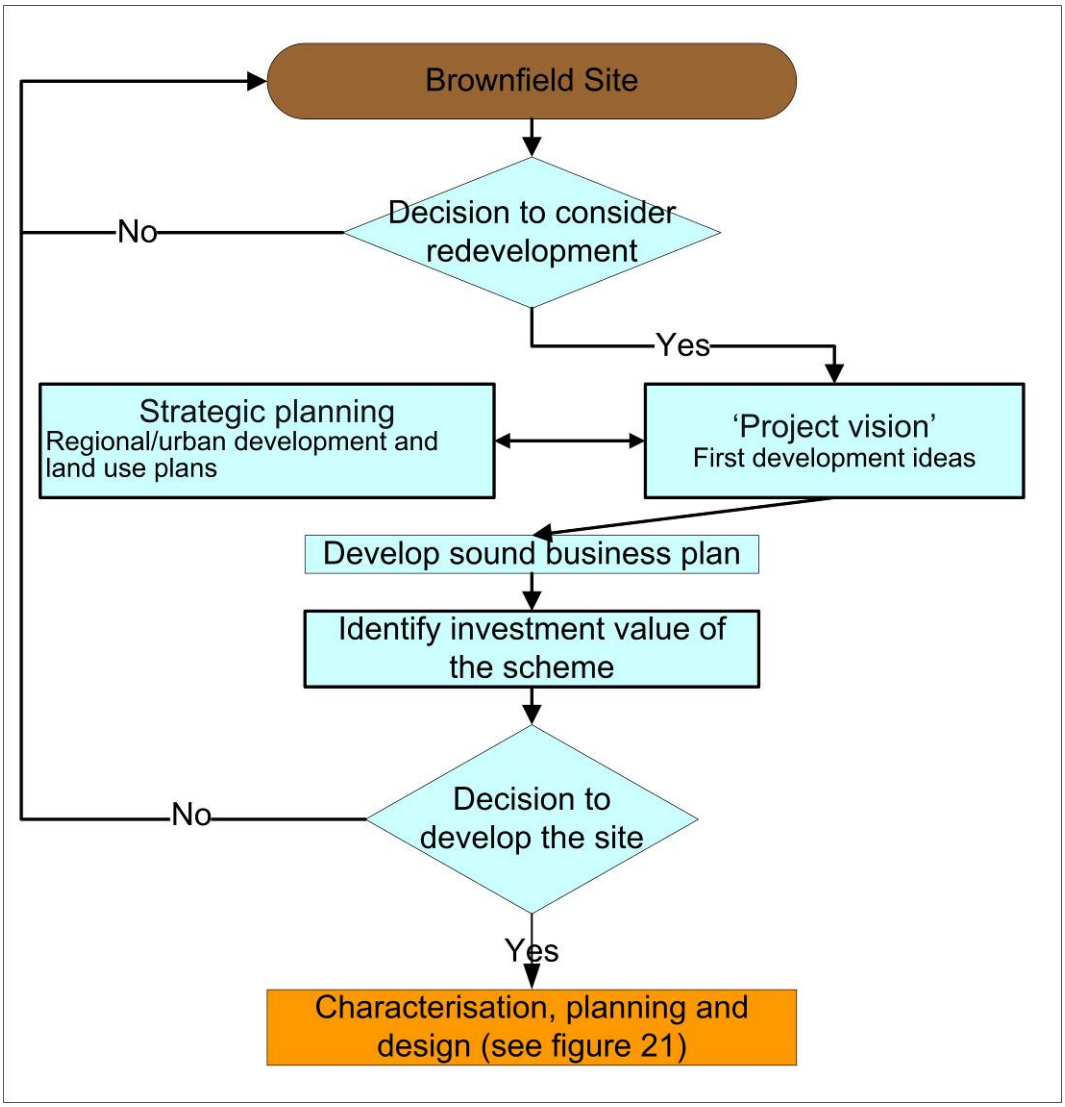


Figure 20: Initiation stage of brownfield redevelopment

The first stage of the redevelopment process is initiation (Figure 20). The process of redevelopment begins when a stakeholder considers redeveloping a specific site. This

decision may be taken for a number of reasons: a landowner may wish to sell their land to raise capital, a developer may require a site to develop, or a local authority or other public body may consider redevelopment will contribute to the achievement of its objectives as set out in the Local Development Framework (Table 6).

Table 6: Motivation of stakeholders for redeveloping a brownfield site (English Partnerships, 2006a)

Stakeholder	Motivation
Land-owner	Short-term profit Manage liabilities
Developer (Trader)	Short-term profit
Developer (Investor)	Medium and long-term return on investment
Developer (Hybrid)	Both short-term profit and medium to long-term return on investment
Regeneration Agency	Deliver policy driven outputs Area-based regeneration Appropriate return on investments
Local Authority	Deliver policy driven outputs Area-based regeneration Appropriate return on investments
Community Enterprise	Locally based objectives depending on the overall objective of the enterprise Often strong focus on economic regeneration and creation of employment opportunities May focus on physical and visual environment
Developer (Public-private partnership)	Combination of the above

Once this decision has been taken, a project vision is developed that outlines the potential redevelopment option or options for a site. This will be developed based on an options appraisal (9.3.2) that involves establishing the baseline market, planning and economic conditions and then determining which options are appropriate given the motives of the leading stakeholder (Table 6). For example, if the objective is short-term profit the emphasis is likely to be placed upon economic viability and market demand. However, if the objective is to contribute to wider regeneration then the emphasis is likely to be placed on how redevelopment can contribute to wider strategic objectives or wider economic growth. The project vision will be developed within the framework of strategic planning relevant to a site which may include

national, regional and local planning policy (section 9.3.1). The outcome of the project vision is a set of possible redevelopment options. Following this a business plan should be developed which involves setting the objectives for the project, including the expected return on investment and screening criteria that define circumstances that could halt interest in a site or project, and devising a strategy to withdraw from the development should this be necessary (Laidler et al., 2002). The business plan will continue to be developed as the redevelopment progresses and provides a framework for managing the business aspects of the project. The redevelopment options identified in the project vision can then be assessed against objectives outlined in the business plan to determine if any are likely to provide the required return on investment. At this stage, a decision will be made on whether to develop the site or not. In general, if a redevelopment option, or a number of options, is likely to provide the required return on investment then the redevelopment will progress to characterisation, planning and design. If no redevelopment options are considered to provide the required return on investment the project must return to an earlier stage, to identify alternative redevelopment options, alter the project objectives or be abandoned.

4.2.3 The Characterisation, Planning and Design Stage of Brownfield Redevelopment

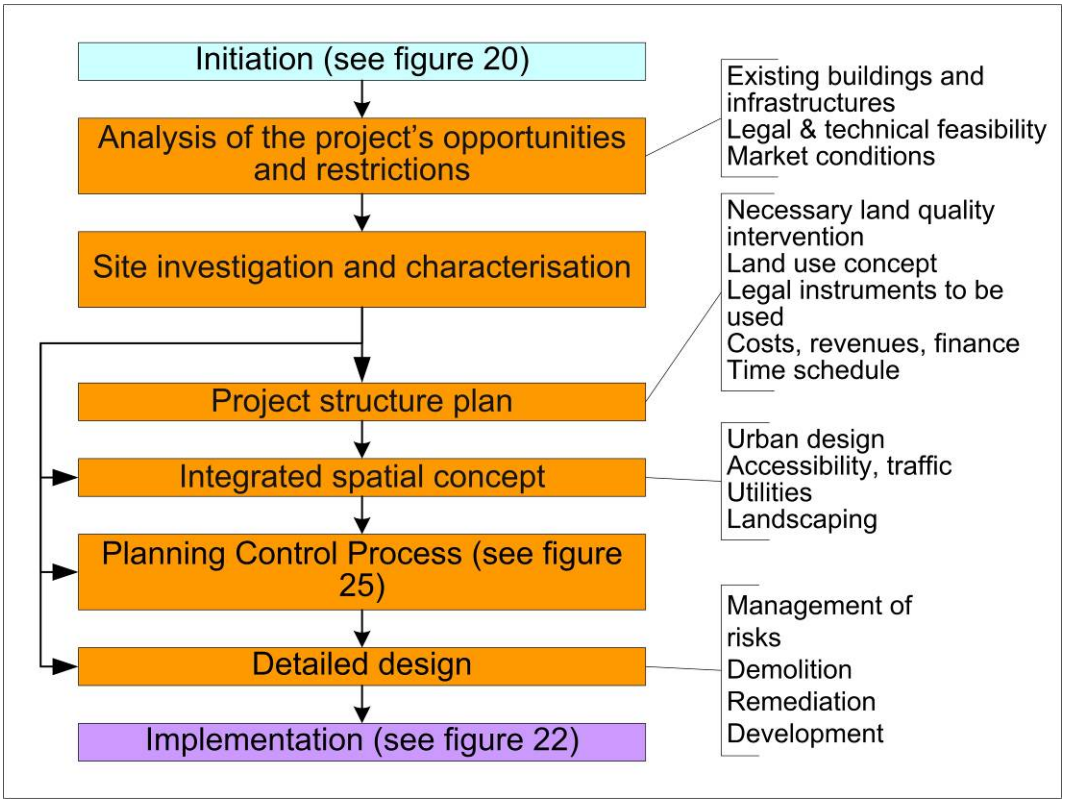


Figure 21: Characterisation, Planning and Design stage of brownfield redevelopment

The *Characterisation, planning and design* stage (Figure 21) involves establishing a scheme to meet the project objectives within the constraints of a particular site. To do this, site investigations will be undertaken to establish the site-conditions, identify the project's opportunities and identify any constraints on the redevelopment. These will inform the general planning of the redevelopment, including the selection of a redevelopment option, and the detailed design required to implement the proposed after use. Although the three components are represented as being sequential the process is generally quite iterative at this stage.

Site investigations are carried out to determine what hazards may be present and what risks they present. It has been stated that

> "you pay for site investigations whether you carry one out or not" (Institute of Civil Engineers, 1991).

This means that, while it may be a financial saving to not carry out a site investigation, this will often lead to unexpected problems later in the project which can result in delays in the project and increased costs. Therefore, over the life time of the project the cost of a site investigation will be paid for either directly (to have one carried out) or indirectly (to remedy unforeseen complications). The second option is generally problematic and often more expensive.

The aim of a site investigation is to characterise the aspects of the site's environment that are relevant to redevelopment. Factors that may be investigated during site investigation are shown in Table 7. In addition to investigating the site, the site investigation may also characterise the surrounding urban area including the factors shown in Table 8.

Table 7: Brownfield site properties investigated during site characterisation

Natural environment	Biosphere (Biodiversity)	Flora
		Fauna
		Habitats
	Lithosphere (Subsurface conditions)	Contamination
		Geotechnics
		Geology
		Hydrogeology
	Hydrosphere	Hydrology
		Flooding
	Atmosphere	Air quality
Built Environment	Land use	Former uses
		Current uses
		Existing buildings
	Infrastructure	Access to site
		Access within the site
	General site characteristics	Size
		Location
		Site boundaries

Table 8: Properties of urban areas that may be investigated during site characterisation

Natural environment	Biosphere (Biodiversity)	Flora
		Fauna
		Habitats
	Lithosphere (Subsurface conditions)	Contamination
		Geotechnics
		Geology
		Hydrogeology
	Hydrosphere	Hydrology
		Flooding
	Atmosphere	Air quality
		Noise pollution
Built Environment	Land use	Former uses
		Current uses
		Existing buildings
	Infrastructure	Access to site
		Access within the site
	General site characteristics	Size
		Location
		Site boundaries
Social	Demographics	Population
		Race / Ethnicity
		Religion
		Age
		Gender
		Income
		Socio-economic status
		Marital status
		Sexuality
		Ownership (Home, Car, Pet, etc)
		Mobility (in terms of travel time or number of vehicles available)
		Educational attainment
		Employment status
	Quality of life and deprivation	Cost of living
		Culture
		Education
		Provision of services
		Access to services
		Health
		Recreation / free time
Economic situation	Supply and demand for goods and services (i.e. market assessments)	Labour
		Housing
		Retail
		Leisure / recreation
	Finance	Personal finance
		Business finance
		Public finance
Policy	Planning policy	Local
		Regional
		National
	Other policy	Local
		Regional
		National

Site characterisation may also involve investigating the impact of redevelopment on the site and the surrounding urban area and any risks posed by these. On a brownfield site the primary focus of risk assessment will be on geotechnical and geo-environmental risk (section 4.3.5). A number of other sources of risk may require investigation depending on the site, its location and, the scale and nature of the project including risk from flooding, increasing flood risk elsewhere (section 4.3.8) and the impact of the development on the environment (section 4.36). In addition to characterising the site as part of the risk management process, information that will be collected to assist the planning and design stages of the project.

The planning process of brownfield redevelopment refers here not to the development control process (for development control see section 4.34), but to land use planning. During this stage detailed land use planning is carried out and the redevelopment option for a site will be chosen (section 4.3.2). The process of planning will have begun during the initiation stage, when development options were considered. The initial plans, developed during initiation (section 42.2) will be developed in further detail including the general layout of the site and where specific components of the development are to be located. Once the details of the development proposal have been finalised planning permission can be sought (section 4.3.4).

Detailed design will depend on the redevelopment option chosen but will require design of any components that will be needed to deliver the project and include the issues shown listed in Table 9.

Table 9: Issues addressed within detailed design

Finalisation of the detail of the site layout
Layout of roads and paths
Site access
Landscaping
Infrastructure works
Architectural design of buildings and other structures, and design of building services
Design of work to manage contaminated land
Design of work to manage sub-surface risks
Design of work to manage flood risk and surface water regime
Design of work to mitigate environmental impact
Demolition or restoration of existing buildings
Health and safety during construction
Site characterisation and investigation work

The transition from this stage to the next, implementation, takes place when work begins on the site. The boundary between this stage and the implementation stage is blurred as some aspects of the planning and design stage will continue after the implementation stage has begun but a significant milestone is planning permission as this must received before the project can proceed.

4.2.4 The Implementation Stage of Brownfield Redevelopment

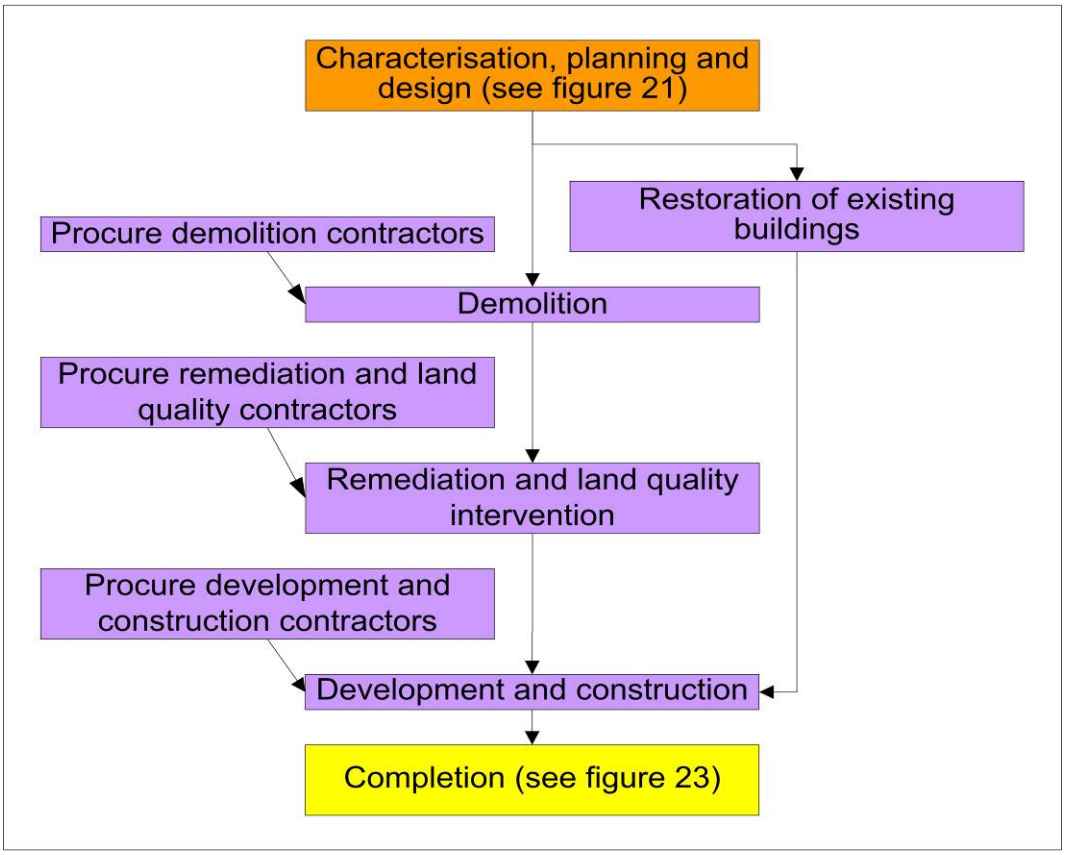


Figure 22: Implementation stage of brownfield redevelopment

The *implementation stage* involves carrying out the work required to deliver the development as planned in the previous stage (Figure 22). The nature of the work carried out will depend upon the state of the site and the proposed after use but will usually include demolition, remediation, geotechnical work, construction, landscaping, works to mitigate potential risks such as flooding, and the installation of roads and other infrastructure.

This work is unlikely to take place simultaneously, instead the different activities will be carried out as necessary during the project, for example demolition often takes place prior to intrusive site investigation, but the bulk of the work will take place only after the planning and design stage has been completed. The implementation stage is complete once the construction objectives have been achieved and the site is ready for its after use.

4.2.5 The Completion Stage of Brownfield Redevelopment

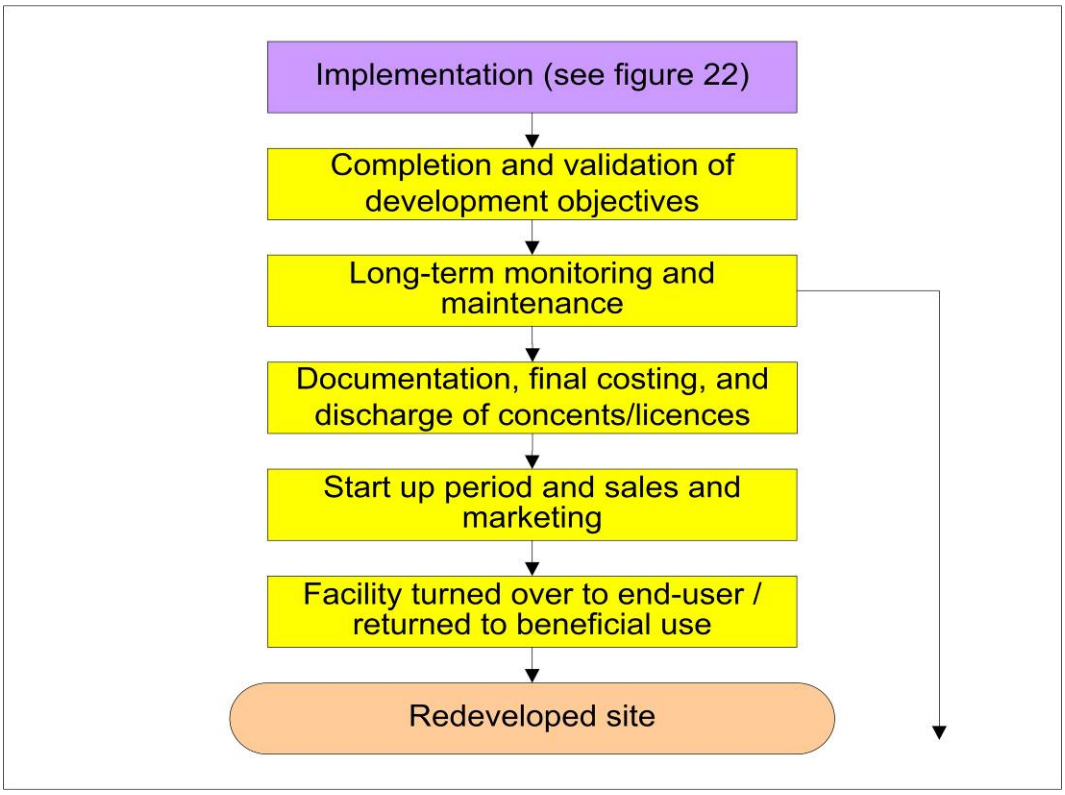


Figure 23: Completion stage of brownfield redevelopment

The final stage of redevelopment is the completion stage (Figure 23). During this stage the completed development is transferred to the end user. This may be through the sale of the development directly to an end-user, the sale of the development to a third party who will manage the property, or the lease of the development to an end user. The type of transfer that takes place will depend on the individual project and should have been planned from the early stages of the development process. Once the redevelopment process reaches this stage the transfer of land is, in general, no longer specific to that of a brownfield: it can now be considered to be like the transfer of any piece of completed real estate or developed land.

On-going maintenance and monitoring may be required following the completion of remedial works to manage land contamination, geotechnical risk (such as subsidence of actively degrading landfill), flood risk or environmental impact and where this is the case the arrangements should be included within the conditions of the land transfer.

The end of the completion stage, and the entire redevelopment process, takes place when the end users start using the site for its intended purpose: for example when workers move into an office, when people move into a dwelling, when shops open for business or when people begin using new recreational facilities or open spaces.

4.3 Key Issues within Brownfield Redevelopment

There are a number of issues that are of particular importance to brownfield redevelopment which must be addressed as part of the redevelopment process. Some, such as spatial planning and development control, will be encountered at all sites, others, including flood risk and land assembly, will only be relevant to some sites. This section examines some of the key issues in brownfield redevelopment, describing

why they are of relevance to brownfield redevelopment and explaining how they can be addressed within the redevelopment process.

4.3.1 Land Use Planning: Bringing Land Forward for Development

In England, local planning policy plays a key role in brownfield redevelopment (Cullingworth and Nadin, 2002). Local Development Frameworks, and the Local Plans they are replacing (see chapter 3), can attract developers to brownfields as site specific land use allocations provide some certainty about what development will be allowed (Barker, 2006). Masterplans can provide strategic thinking to guide development at an area or site specific level by outlining development proposals including broad design principles, environmental enhancements and infrastructure improvements (CABE, 2004; Bell, 2005). This can encourage redevelopment either directly or indirectly by reducing development risk or increasing the attractiveness of an area, for example by creating a high quality public realm (Bell, 2005). Site specific masterplans, often referred to as Development Briefs when prepared as supplementary planning guidance, can provide more detailed guidance on the development of individual sites and usually provide further information related to sites identified in the Local Development Framework, or Local Plans (Cowan, 2002).

In summary, land use planning can provide the stimulus to initiate redevelopment and can have considerable influence in shaping redevelopment as it provides a framework for planning and design.

4.3.2 The appraisal of redevelopment options for brownfield redevelopment projects

In regeneration, options appraisal is the process of narrowing down a range of options to identify the particular project to be undertaken (Neighbourhood Renewal Unit,

2007) and the primary focus of this thesis is to develop a method that can be used to select a redevelopment option for a brownfield site (section 1.1). The roadmap presented in this thesis includes a number of stages when decision are made about the redevelopment option for a site, which is when options appraisal is likely to be carried out, including:

- During the strategic planning stage, when planners and other policy makers are developing regional, local and site-specific planning policy (see Figure 20 and sections 4.2.2 and 4.3.1);
- Before a developer acquires a site (section 4.3.3);
- During the development of a 'project vision' (see Figure 20 and section 4.2.2) and;
- When a final decision is made about the redevelopment option for a site during the characterisation, planning and design stage of redevelopment (section 4.2.3).

The main approach to appraising development projects presented in the literature is a two stage process that assumes an option can be selected purely on a financial basis (Cadman and Topping, 1995; Isaac, 1996; Harvey, 2000; Havard, 2002). The first stage involves researching the market to determine what demand exists for development and the potential to obtain planning consent for the change required to meet these demands (Cadman and Topping, 1995; Havard, 2002). The second stage involves an economic analysis to determine the profit each option will make (Cadman and Topping, 1995). The profit is considered to equal the value of the developed site less the cost of development (Isaac, 1996; Harvey, 2000). This approach does not consider the contribution of the development to wider objectives such as regeneration and therefore specific guidance has been developed for the assessment of

regeneration, renewal and regional development projects (the 3Rs) which follows the procedures described in the Treasury 'Green Book' on appraisal and evaluation in Central Government (ODPM, HM Treasury, 2003; ODPM, 2004a). Although primarily aimed at those in central government and its agencies (i.e. the public sector) the guidance provides a good outline for the options appraisal process regardless of who is carrying out the appraisal (Figure 24). However, this approach is also financially based as it involves estimating the value of the benefits delivered by the project and comparing these to the cost of delivery (ODPM, 2004a).

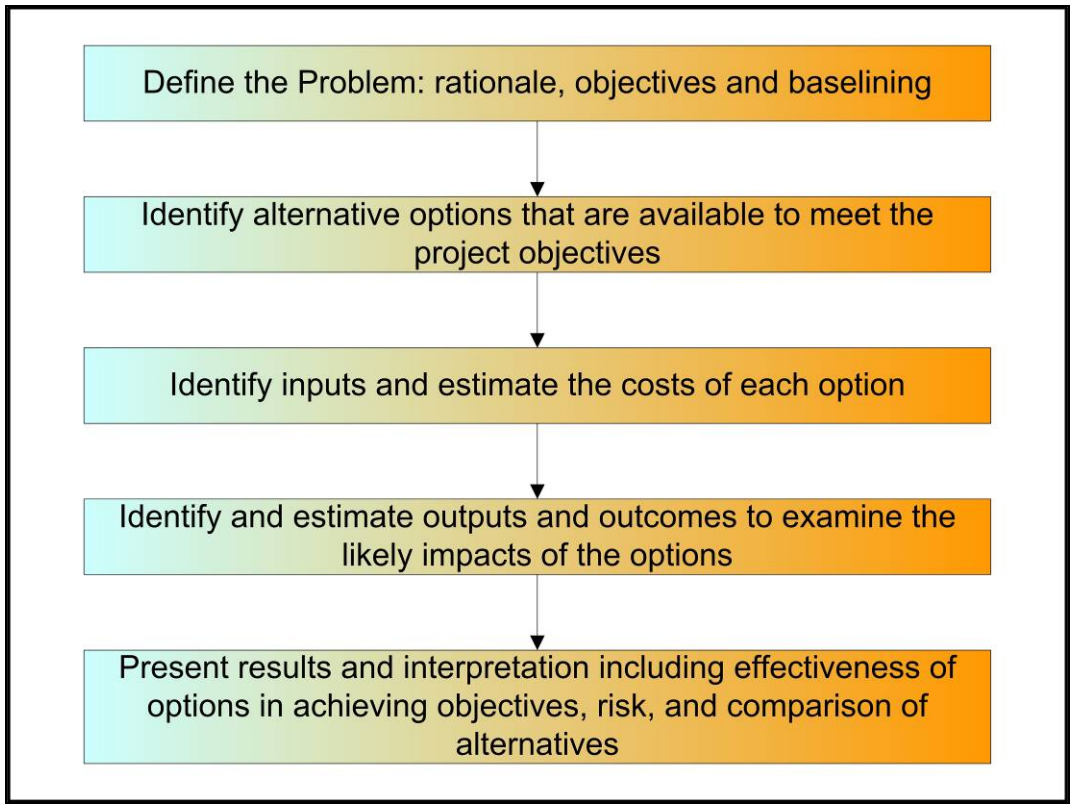


Figure 24: Options appraisal for regeneration, renewal and regional development projects (ODPM, 2004a)

The weakness with the options appraisal process presented above, and the primary reason that there is no specific method to determine the most appropriate redevelopment option for a brownfield site (see Chapter 1), is that there is currently no method to identify and estimate the likely impacts of redevelopment options for a project in a given context. Therefore, a tool or method needs to be developed to assess

the impact of brownfield redevelopment on the surrounding urban area (see chapters 6, 7 and 8).

4.3.3 Site Acquisition, Land Assembly and Brownfield Redevelopment

Brownfield sites often have fragmented ownership which either restricts development to smaller sites or requires land to be assembled into parcels suitable for development (Tiesdell and Adams, 2004). Land assembly is usually addressed during the initiation stage of redevelopment and can be achieved through agreements between the parties involved or through compulsory purchase (Table 10). Prior to acquiring a site a developer is likely to carry an appraisal of the potential redevelopment options for a site (Cadman and Topping, 1995. Section 4.3.2)

Table 10: Site assembly options (Harpum, 2000; English Partnerships, 2006a)

Land assembly option	Description
Outright purchase	The developer purchases the land outright from the land owners
Option to purchase land	An agreement by which the land owner grants the developer the option to purchase the land within a specified period
Conditional contracts	The developer agrees to buy the land if certain conditions are met, for example if planning permission is granted
Compulsory purchase	The statutory right of certain public bodies to purchase land compulsorily

Compulsory purchase powers are available to authorities, including Local Authorities, Regional Development Agencies and English Partnerships, to enable them to acquire land for a particular purpose or scheme where it has not been possible to do so by agreement (ODPM, 2004b). Due to the process of compulsory purchase being slow, costly and complex it is usually the last resort in attempts to assemble land (Adams et al., 2001).

Land assembly can be a major barrier to redevelopment as development is unlikely to proceed until the developer has secured the site through one of the means described above.

4.3.4 Development Control and Planning Permission

The planning system regulates development through the granting of planning permission and, within the redevelopment of a brownfield site, this permission will be applied for during the characterisation, planning and design stage (Figure 25).

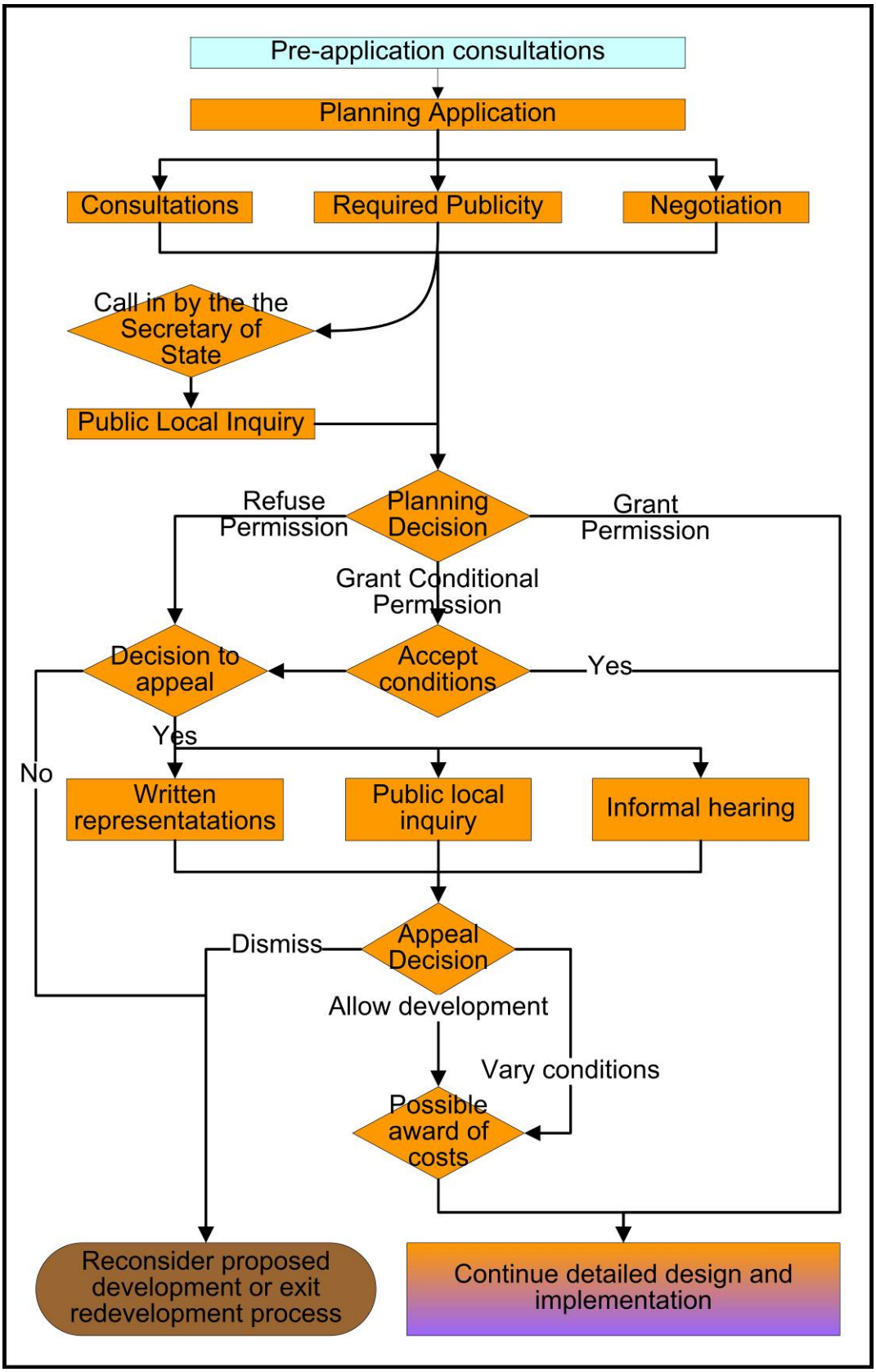


Figure 25: Roadmap of the English Planning Control Process (After Rydin, 2003)

Under the Town and Country Planning Act (1990) there are two types of planning permission that can be applied for: outline planning permission and full planning

permission. Outline planning permission is applied for where the applicant wishes to establish the principle of the proposed development but not necessarily the full details and this type is planning permission can be granted subject to a condition requiring approval of one or more reserved matters (Table 11) (DCLG, 2006b). Full planning permission is applied where the applicant wishes to establish both the principle and detail of the development.

Table 11: Reserved matters in relation to outline planning permission (DCLG, 2006b)

Layout	The lay out of buildings, routes and open spaces
Scale	The height, width and length of each building
Appearance	The aspects of a building or place which determine the visual impression it makes, excluding the external built form of the development
Access	Accessibility to and within the site
Landscaping	The treatment of private and public space

A planning application must include adequate information for the local authority to be able to understand and evaluate the impact of the proposed development in order for it to make a decision that takes proper account of national, regional and local planning policies (DCLG, 2006b). The exact nature of the information required will depend on the scale and complexity of the proposed development, the site and the surrounding area but at as a minimum an outline application should include:

The use or uses proposed for the development;

The amount of development proposed for each use;

The indicative layout for the development;

Indicative upper and lower limits for height, width and length of each building within the site boundary;

Indicative access points, and;

A design and access statement (DCLG, 2006b).

A full planning application should be supported by the information required for an outline application and information relating to the reserved matters (DCLG, 2006b). In addition, the Local Authority may request further information to allow it to understand and evaluate the impact of the proposed development. For example, for all major developments (residential development for 10 or more dwellings or on site larger than 0.5 hectares or any other development where floorspace proposed is greater than 1,000 square metres or the site is larger than one hectare) Nottingham City Council requests:

Material illustrating the development proposals (pictures, models etc);

Draft Section 106 obligation;

Environmental assessment;

Contaminated land survey;

Floor risk assessment;

Protected species survey;

Training and Employment statement, and;

Transport assessment and travel plan (Nottingham City Council, 2007).

The decision on whether to grant planning permission is made by a planning control committee of the local council which is advised by planning officers and should comply with the local development plan unless material considerations direct otherwise (Rydin, 2003). The decision can be:

1. To reject the application;
2. To grant conditional permission, or;
3. To grant unconditional permission

In 2005/2006 82 percent of planning applications were granted (DCLG, 2006d) but it is far more common for permission to be granted conditionally than unconditionally.

When conditional planning permission is granted the developer must fulfil the conditions as part of the development or over turn them at appeal.

4.3.5 Managing Land Contamination within the Brownfield Redevelopment Process

Land contamination is caused by the previous land uses or by the existence of natural substances in the ground (Rudland et al., 2001; Nathanail and Bardos, 2004). On a brownfield site, the nature of the previous use is in general the most significant factor determining the type and extent of contamination and although brownfield sites are not necessarily contaminated this should be considered as part of the redevelopment process (Syms, 2004; van Ree et al., 2007). The Government's policy is that a site should be suitable for the proposed use and that after redevelopment it cannot be designated as contaminated land under Part 2A of the Environmental Protection Act 1990 (ODPM, 2004f; Defra, 2006). Contamination is usually considered during the initiation stage of redevelopment when assessing the viability of redevelopment but it is part of the application for planning permission that contamination is considered in detail. Where land being developed is suspected of being affected by contamination, a risk assessment must be carried out to identify any existing or new unacceptable risks and these risks should be managed as part of the development. Development control (see above) is the primary regulatory regime for contaminated land in relation to future use of land and planning conditions can be used to secure appropriate investigation and remediation. However, it should be noted that a broader definition of contaminated land is used in development control than under Part 2A (ODPM, 2004f).

Contaminated land should be managed using a risk based staged approach (Figure 26) following the model procedures for the management of contaminated land (CLR 11) (Defra and Environment Agency, 2004).

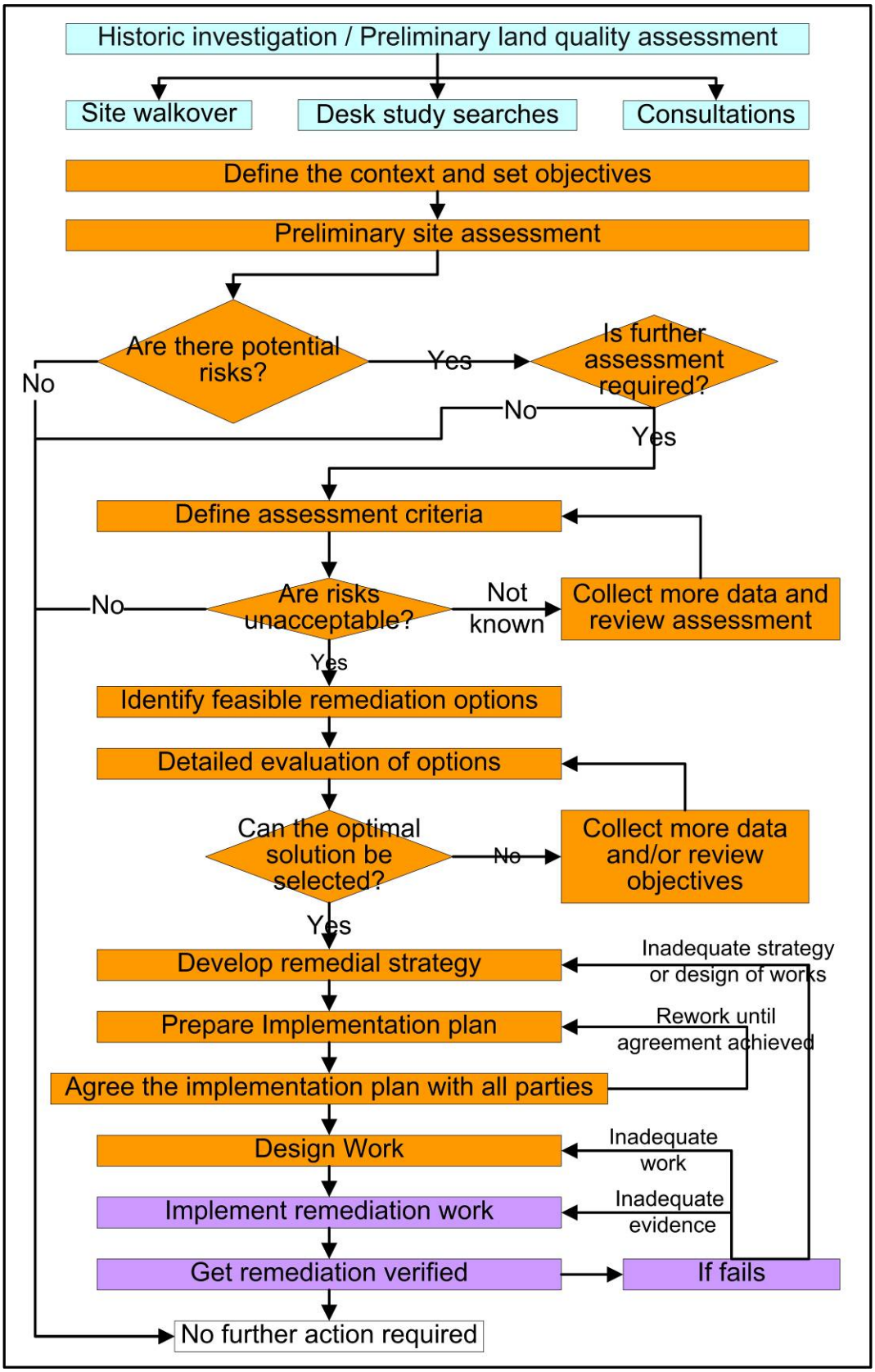


Figure 26: Roadmap of the contaminated land management process (After Defra and Environment Agency, 2004)

The process can be split into three stages:

1. Risk assessment;
2. Development of a remediation strategy, and;
3. Implementation of the remediation strategy.

Risk assessment involves identifying potential risks and assessing if they are unacceptable. If no risks are identified or the identified risks are not considered to be unacceptable then no further action. The development of a remediation strategy involves identifying all the remediation options that will reduce the risk to an acceptable level and selecting an appropriate option or combination of options. The implementation of the remediation strategy involves planning, carrying out and verifying the work required to implement the remediation strategy. Once the works have been verified then either no further action is required or long term monitoring (for example monitoring contaminated levels after source removal) and maintenance (of in-situ remediation techniques such a permeable reactive barriers or of monitoring equipment) are carried out to ensure the remediation strategy continues to manage the risk.

4.3.6 Brownfield Redevelopment and Environmental Impact

Environmental Impact Assessment (EIA) is the process of collecting information about the environmental impact of a development and taking this information into account when making decisions relating to planning permission (Figure 27) (Bell and McGillivray, 2006). The requirement to assess the environmental impact of new development derives from European Community Law and is translated into English law through the planning law (CEC, 1985; CEU, 1997; The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations, 1999).

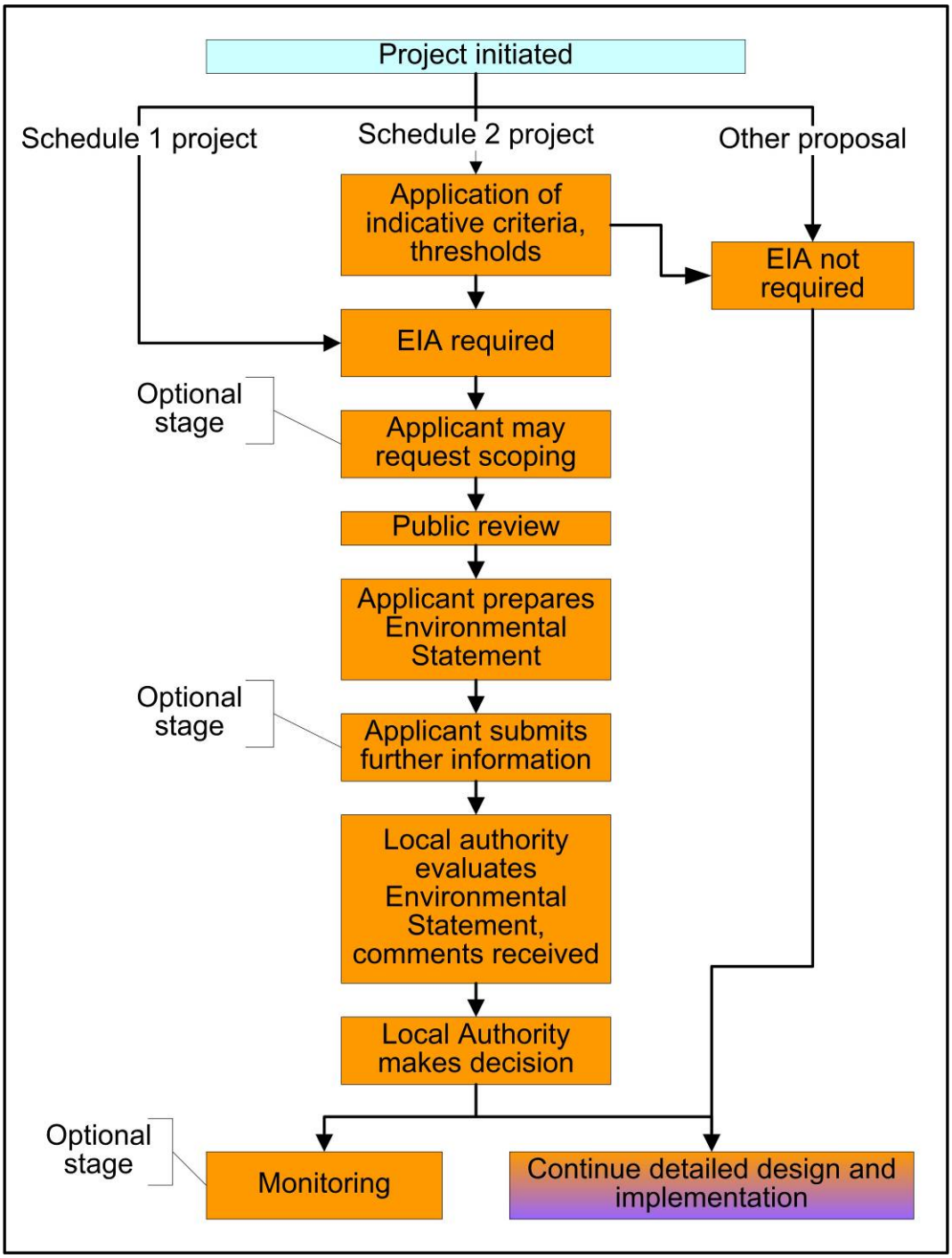


Figure 27: Main steps in the EIA process as part of a planning decision (RTPI, 2001)

The scope of an the environmental assessment should be discussed between developers and the Local Authority prior to preparation of the environmental statement is begun but at least the information listed in Table 12 should be provided as well as information that is reasonably required to assess the environmental effects of the development (ODPM, 2000).

Table 12: Information that must be included in an Environmental Statement (ODPM, 2000)

A description of the development
A description of measures to mitigate any significant adverse effects
The data required to identify and assess the main environmental effects of the development
A description of the alternative development options considered
A non-technical summary of the information of the above information

The assessment should consider both the positive and negative effects on:

Human beings;

Buildings and man-made features;

Flora;

Fauna;

Geology;

Land;

Water;

Air and climate, and;

Other indirect and secondary effects associated with the project.

For a brownfield redevelopment the requirement for EIA will depend on the scale of the development, the size of the site and the environmental sensitivity of the site or surrounding area, but in general EIA is likely to be required where the area of development is greater than 0.5 hectares (The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations, 1999).

4.3.7 Brownfield Redevelopment and Biodiversity

Brownfield sites can have greater biodiversity than greenfield sites so the potential loss of biodiversity can be a significant issue (TCPA, 2004; Hopkins, 2005). However, redevelopment, if managed properly, can reverse the trend of habitat destruction in urban areas (TCPA, 2004; Baines, 2006). Protection for biodiversity derives from a

variety of sources including European and English law (CEC, 1979; Wildlife and Countryside Act, 1981; CEC, 1992; The Conservation (Natural Habitats &c.) Regulations, 1994) and the policy in England is that development and regeneration should have minimal adverse impact on biodiversity and enhance it where possible (Defra, 2002). This policy is supported by planning policy and good practice guidance aimed at ensuring biodiversity is considered as part of redevelopment (TCPA, 2004; ODPM, 2005f; and, 2005b; ODPM et al, 2006). Biodiversity is likely to be addressed during the characterisation, planning and design stage of redevelopment (Figure 28) and may also be considered as part of EIA (IEEM, 2006).

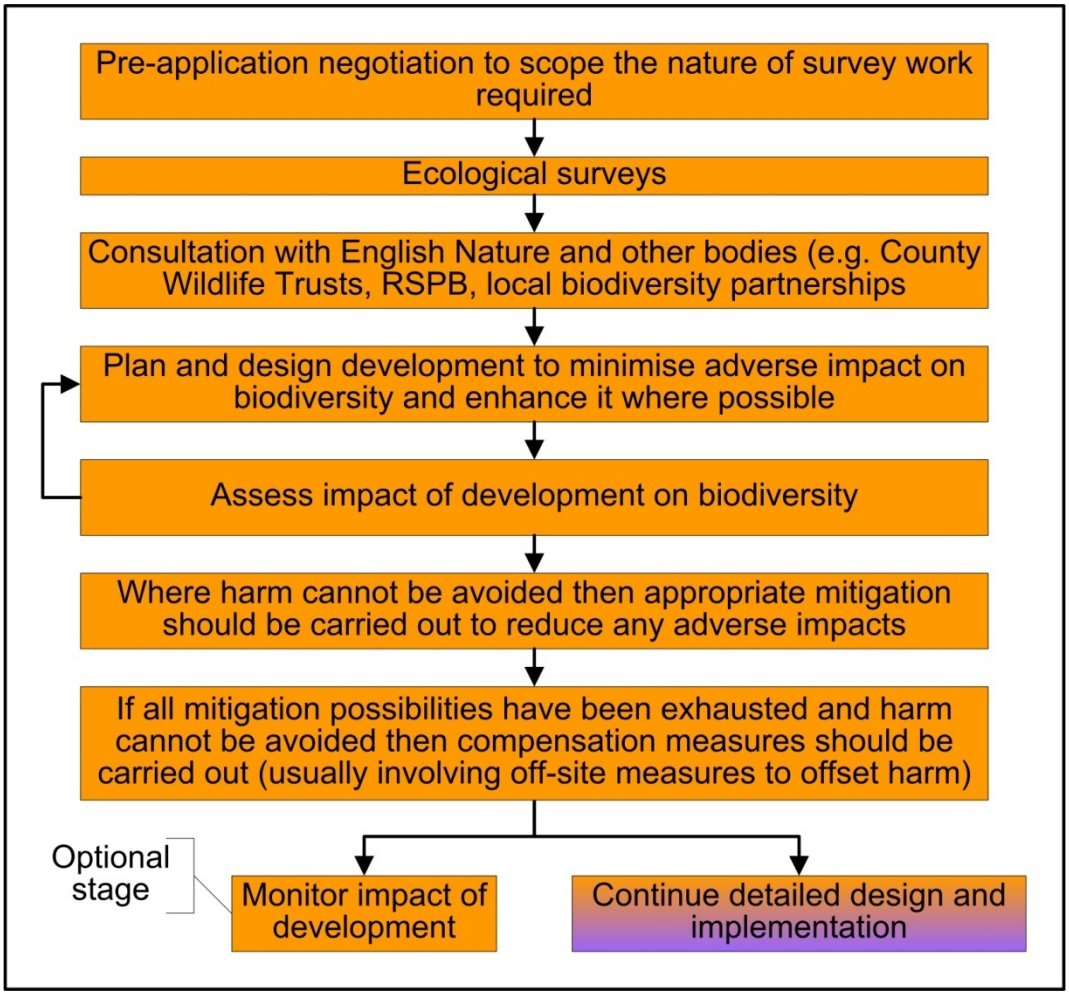


Figure 28: Incorporating biodiversity into the redevelopment of a brownfield site (The South East England Biodiversity Forum, 2002; ODPM, 2006)

4.3.8 Brownfield Redevelopment and Flood Risk

Many brownfield sites are located within floodplains and redevelopment has the potential to increase flood risk (Environment Agency, 2003; DCLG, 2007a). Government policy advocates a risk-based approach to ensure that development is not at risk from flooding and does not increase the risk of flooding elsewhere (DCLG, 2006i; and 2006c). Therefore, flood risk should be considered as part of brownfield redevelopment to ensure that development does not cause an increase to flood risk (Figure 29). A flood risk assessment will be required for all sites in areas of medium and high flood risk and for sites above one hectare elsewhere (DCLG, 2006i).

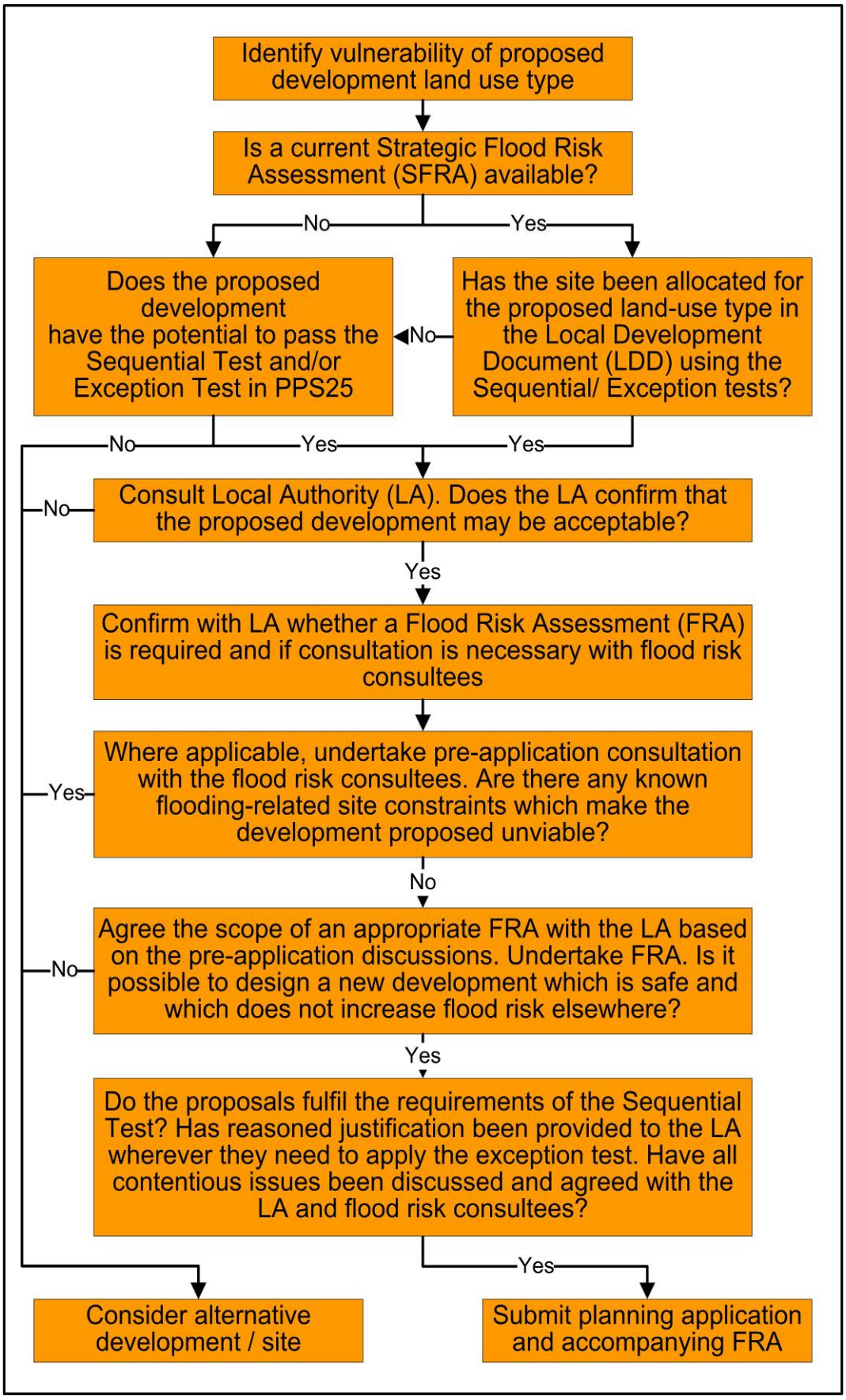


Figure 29: Flood risk and brownfield redevelopment (DCLG, 2006i)

4.3.9 Business Aspects of Brownfield Redevelopment

The roadmap presented in this chapter has focused primarily on the physical and planning aspects of brownfield redevelopment and does not include the business, financial and project management aspects of redevelopment in great detail. This is not to say that they are not of great importance instead it is a reflection that the literature and previous roadmaps, particularly that of Laidler et al (2002), provide comprehensive guidance on these aspects of the redevelopment process. A detailed introduction to the financial aspects of property development can be found in Isaac (1996) and Havard (2002).

4.4 Summary

In this chapter, the complex multi-dimensional process of brownfield redevelopment is presented as extracts of a roadmap of the entire process that has been developed by reviewing and expanding existing descriptions of the process. During the development of the roadmap two lists were produced that are required for Brownfield REMIT/RESPONSE (see chapter 7), one of the characteristics of brownfield sites, the other of the characteristics of urban areas.

The development of the roadmap indicated that the influence of policy on the redevelopment process occurs largely during the initiation and characterisation, planning and design stages. Planning policy has considerable impact on the redevelopment option chosen for a brownfield site as the uses permitted for a site are often set out within local and sub-local planning policies. Furthermore, developers must gain planning permission from the Local Authority to be able to redevelop a site and the negotiations to gain planning permission, and the conditions attached to it, can have a significant influence on the design of the redevelopment. It is also clear that the size of the site and the scale of development will have a significant impact on how

policy influences redevelopment as many of the regulatory processes (e.g. EIA, flood risk assessment, Development Control) are triggered or altered by development above a certain threshold. Therefore, smaller sites are subject to less regulatory control than large brownfield sites.

One aspect of the redevelopment process that causes concern is the optional nature of monitoring the impact of redevelopment. In the processes of EIA (Figure 27) and incorporating biodiversity into redevelopment (Figure 28), monitoring the impact caused by redevelopment is considered to be an optional stage, potentially undermining the impact assessment process. If the actual impact of development is not monitored, the assessment process has the potential to become a matter of convincing the Local Authority that redevelopment will have no significant adverse impact rather than genuinely assessing the impact. A lack of monitoring has wider implications as redevelopment is often promoted due to its role in regenerating urban areas and unless the impact of redevelopment is monitored these claims remain unproved. To explore whether brownfield redevelopment does deliver the regeneration that is promised, the long-term impact of policy-led brownfield redevelopment will be analysed in the next chapter.

Chapter 5: National Garden Festivals

This chapter analyses how successful the National Garden Festivals were at delivering the long-term re-use of brownfield sites. The analysis focuses on three aspects: the planning and redevelopment of the sites in preparation for the festival, the redevelopment and re-use of the site after the festival and the state of the site today. The last two festivals have not been analysed as National Garden Festival Gateshead was held over a number of sites where as the others were based on a single site and the Garden Festival of Wales Ebbw Vale took place in a rural area, and therefore falls outside the boundary of this work. Further more, the literature review and initial analysis on these two sites indicated that no further lessons were likely to be learnt by analysing in detail the last two festival sites. The chapter begins with an introduction to the National Garden Festivals as an urban regeneration policy then analyses each of the garden festivals followed by a discussion of the findings made and the chapter concludes with a summary.

5.1 The National Garden Festivals as a Brownfield Regeneration Policy

The National Garden Festivals was a Department of Environment policy to attract private sector investment to post-industrial urban areas. The policy proposed to achieve this by improving the environment of an area by redeveloping a brownfield to create a landscaped site as the venue for a one-off garden festival, including themed gardens, exhibition areas, parkland areas, transport rides and other attractions, which could then be sold for development. The festivals were held bi-annually with the first in Liverpool in 1984, followed by Stoke-on-Trent in 1986, Glasgow in 1988, Gateshead in 1990 and Ebbw Vale in 1992 (Figure 30).

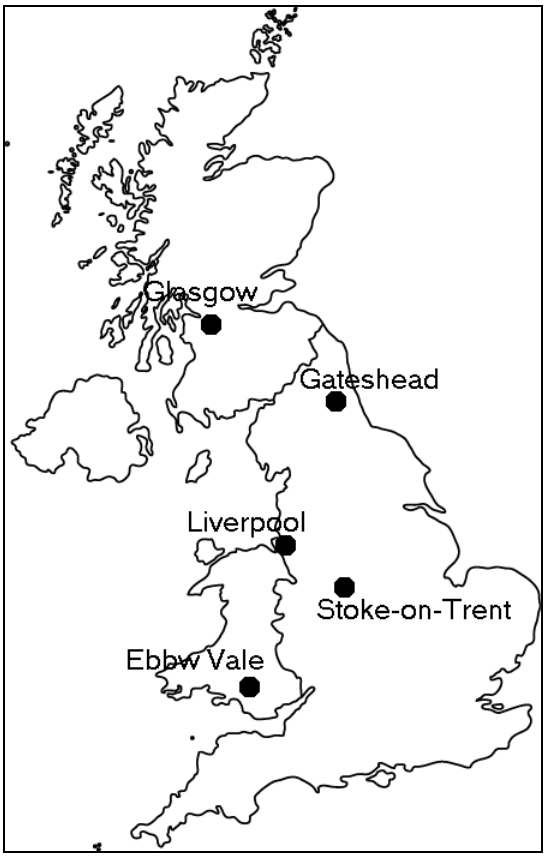


Figure 30: Location of the Garden Festivals within the UK

The primary objective of the National Garden Festival policy was to secure the redevelopment and long-term re-use of derelict sites (Skill, 1992) and the Department of Environment initially eight key objectives which focused on three areas: reclamation of the site; the environment; and the economic benefits of the festivals (Table 13). There were no explicit social objectives of the National Garden Festivals.

Table 13: The key objectives of the festivals adapted from (PA-Cambridge-Economic-Consultants, 1990).

Reclamation 1. Rapid reclamation of large derelict sites against a tight timescale 2. The reclaimed site should be of higher landscape quality and development than would otherwise be achieved
Environmental 3. Environmental improvement on site 4. The project should act as a spur for environmental improvements over a wider area 5. Longer term environmental benefits for the host town/city and its region, including 'image' effects
Economic 6. Short-term economic benefits for the local area and its wider region due to construction work, operations and franchises associated with the garden festivals, and expenditure related spin-offs from visitors to the festival 7. Longer term economic benefits 8. Stimulation of landscape design and a showcase for the horticultural industries

The idea of using garden festivals as a policy initiative for urban regeneration is based upon the German *Bundesgartenschau* and the decision to introduce the idea to Britain was taken soon after the 1979 general election which brought the Conservative party to power. However, the idea had been suggested to Michael Heseltine, the minister responsible for introducing the festivals, while the Conservative party was in opposition (Heseltine, 2000; Theokas, 2004). The major difference between the proposed implementation of the UK festivals and their German counter parts was that in the UK they were intended to be an interim use for the land to facilitate development for hard-end uses, whereas those held in Germany and other parts of Europe were intended to revitalise derelict sites to provide public open space. Another difference between the British festivals and the German model was that the timescales involved were much shorter: in Germany the festivals sites were prepared over a ten year period but in Britain timescales for site preparation were between two-and-a-half years and five-and-a-half years.

The locations for the festivals were chosen on a competitive basis in which local authorities were invited to bid to host a Garden Festival. In the first round of bidding Liverpool was chosen to host the first festival and Stoke was chosen to host the second. There were three further rounds of bidding to select a location for a each of the three final festivals and these attracted a greater number of bid, for example Gateshead was chosen from among twenty-eight bids (Wear, 1990). The National Garden Festivals of Britain, as an urban regeneration initiative, were brought to a close simply by not instigating a round of bidding for what would have been the 1994 festival.

5.2 Liverpool International Garden Festival[6]

5.2.1 Redevelopment and the Festival

The Liverpool festival of 1984 was built on 45 hectares of a 95 hectare site south of Liverpool city centre which had previously been used as a dock, a municipal landfill, a petroleum storage depot and an oil storage depot. It became derelict due to industrial decline and the reduced need for docklands in Liverpool. Prior to the festival the site had no natural ground conditions, was completely flat and featureless except for derelict structures (Cass, 1983; Clouston, 1984) and suffered localised problems including:

Derelict structures and foundations;

Stability, leachate and methane problems associated with a decomposing landfill;

Contamination associated with oil and petroleum storage, and;

Major siltation and uncontrolled tipping at Herculaneum Docks.

The site was reclaimed and remediated in only eighteen months and the entire process from inception to festival opening took only 31 months. The time it took to deliver the festival was a source of great pride in Liverpool as the process was much quicker than the delivery of the German garden festivals. It has been stated that it was an incredible achievement that what took the Germans eight years to do Liverpool managed in only three (Flamson, 2005). The festival was a massive success attracting over three-and-a-half million visitors in only six months, and was the largest event in the UK since the Festival of Britain in 1951 (Anon, 1984).

[6] The name of each section in this chapter is the name that the festival was known by. The naming of the festivals did not follow any conventions from one to the next.

5.2.2 Post-Festival Redevelopment

After the festival, much of the site was redeveloped, largely for housing but with some commercial and leisure uses. However, a significant part of it was not, except for a theme park that is now derelict, and remains a brownfield over twenty years after the festival closed.

In the first few years after the festival the city council refused to pay for maintenance of the site due financial problems (Parkinson, 1988) and it was sold to a private operator in 1986 by the Merseyside Development Corporation (MDC). However, the private operator went bankrupt during its first season of operation and the MDC was forced to accept responsibility for the site again. The site was opened as a smaller festival during the summers (when this ceased is not clear) but remained closed for most of the year. Since the festival, the main area of the site (area 1 in Figure 31) has been largely undeveloped, except for the above mentioned theme park which opened in the mid-1990s but closed again in 1997 (Theokas, 2004). This area has been subject to a number of proposed developments from a former leaseholder, the development company Wiggins, but all attempts of development have been unsuccessful. Despite this other parts of the site have been redeveloped.

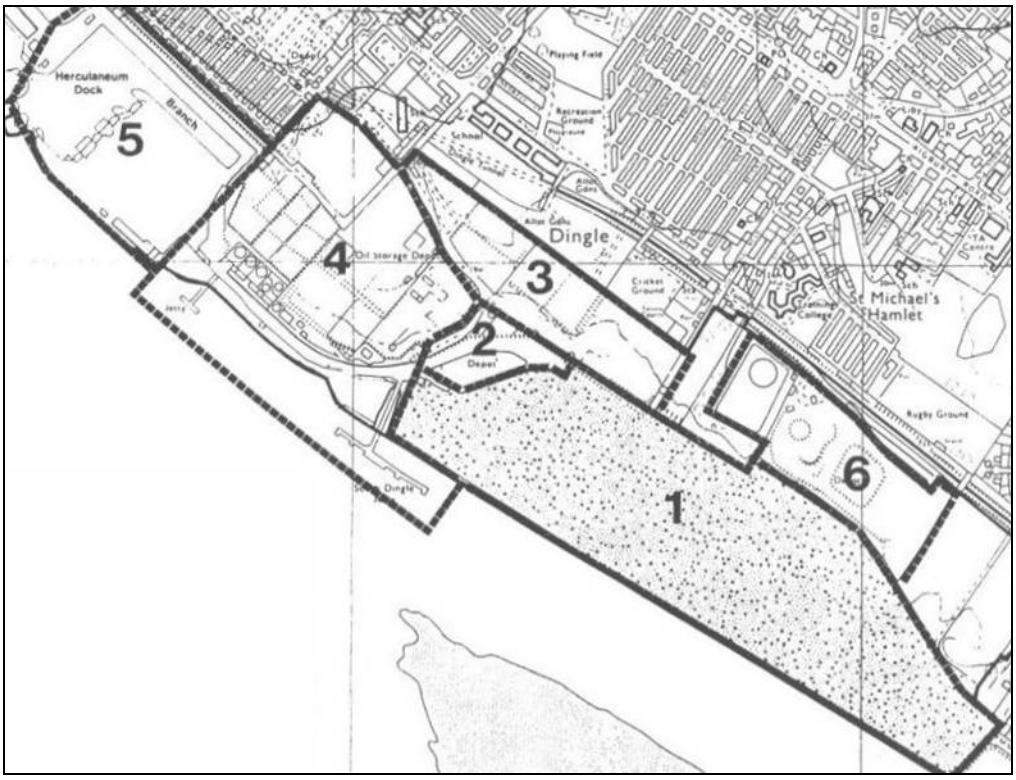


Figure 31: The areas of Liverpool International Garden Festival site (Adapted from Cass, 1983)

The first development that took place was a housing development in the northern part of the site (areas 2, 3 and 4) built in 1986 (Niven, 2004b). Part of the former Herculaneum dock (area 5), which was used as a car park during the festival, was redeveloped for housing, commercial and leisure uses by spring 2001. During the 1990s there was a second housing development in the east of the site (area 6) but Priory Wood (between area 3 and 6) was preserved as public open space. A new link road to the city centre, Riverside Drive, has also been built through the site.

The vision before the festival was that part of the site would remain as a park and riverside amenity and that part of the site would be developed as housing and industry (Chetwynd, 1984): in fact only the housing development has been realised. Couch (1990) argues that, despite this vision, the festival went ahead in the knowledge that insufficient arrangements had been made to ensure that funding would be available to enable the gardens to continue in operation after closure of the festival and that it was a lack of forward planning that led to the site being mothballed. Nearly twenty years

after the event Michael Heseltine, who was the Minister responsible for initiating the National Garden Festival policy, admitted that the festival had not had the desired effect:

> "The purpose was to reclaim a huge swathe of toxic land to provide a site for development. Once the festival had taken place, it got frozen in a time warp instead of becoming a catalyst for change. That was a mistake." (Quoted in Thomas, 2005)

External factors contributed to the failure to secure a long-term after use for the site. Investors who were needed to redevelop the site found Liverpool unattractive due to its poor image and political instability, which was caused by conflict between the Labour-controlled City Council and the Conservative Central Government (Couch, 2003). Liverpool was also suffering from economic problems, and Parkinson (1988) describes the city as being in the throes of economic collapse and near bankruptcy.

In contrast, the festival is still considered to be a resounding success in some circles: it was recently voted by the Landscape Institute as the most influential landscape between 1970 and 2004 (James, 2004). However, this view may not be an impartial one, as the Landscape Institute was heavily involved in both initiating and running the festivals.

An evaluation of the Garden Festivals for the Department of the Environment concluded that the benefits of the festival have been very small, if there have been any at all (PACEC, 1990). PACEC argue that the areas that have been redeveloped for an after-use would most likely have been redeveloped regardless of the festival, and as such little gain has been achieved in this way. Since the site has not been developed for any after-use that would not have been developed by market forces alone, it can be

concluded that, in terms of returning brownfield sites to use, no long term benefits have been achieved by the garden festival in Liverpool.

5.2.3 The Site Today

Today there are 680 homes on the site and the adjoining Riverside Lands, which were redeveloped for the festival and the Riverside Walk has been retained and extended to provide a 7.25 kilometre walk along the River Mersey (MDC, 1998). In addition to the housing development, 8000m^2 of commercial space and 6.9 kilometres of road have been built but 50 hectares of the site remain derelict (NLUD, 2006).

There are plans to develop the remaining derelict portions of the site in time for 2008, when Liverpool will be the European Capital of Culture: The developer Langtree and house builder David McLean have formed a joint venture to develop the site and the Land Restoration Trust (see section 3.3.1) will manage the restored open space (Niven, 2004a; Land Restoration Trust, 2006).

5.3. The National Garden Festival Stoke '86

5.3.1 Redevelopment and the Festival

The 66-hectare site of the Stoke festival, located west of the city centre, was left derelict after the closure of Shelton Bar Steel Works in 1978. Other previous land uses include mining and a number of industries related to steel making and after the closure of the steel works the site became the largest derelict site in the West Midlands (Titchener, 1995). The previous land uses left the site with a number of problems that required remediation including derelict buildings and foundations, abandoned mine shafts, buried slurry lagoons, disused infrastructure and zinc and manganese contamination (Butler, 1985). The redevelopment, which cost £9.5 million, took less than two and a half years and consisted of three main components: earthworks,

infrastructure works (road works, sewers and services) and landscaping (O'Connell, 1986).

Over two million people visited the festival in the summer of 1986, which was less than had been hoped for: this has been attributed to poor weather conditions during planting and the festival itself (PACEC, 1990).

5.3.2 Post-Festival Redevelopment

During the festival preparations, plans were formulated for the redevelopment of the site after the festival and these bore fruit when the site was sold to St. Modwens property developers, who built a mixed-use complex, Festival Park, consisting of apartments, offices, a dry-ski slope, a multi-screen cinema, bowling alley, retail outlets and the UK's most successful water park (Niven, 2004b). Festival Park brings tens of millions of pounds a year to the local economy and has created between 2500 and 3000 jobs (Thomas and Hague, 2000; Davies, 2004). St. Modwen estimate the site is now worth over £100m, and the return on the investment has been massive (Davies, 2004). In addition St. Modwen consider Festival Park to be their most successful development ever (Glossop, 2002).

In 1988, the festival had already acted as a catalyst in securing four and a half hectares of development of the site: a marina complex, the city council's central nursery and the headquarters of the North Staffordshire Chamber of Commerce and Industry (Anon, 1986). Despite having initially ruled out the use of the site for retail, the council decided to allow retail development provided that part of the site was developed for leisure purposes. Planning permission for a mixed scheme of leisure and retail was granted to St. Modwen Properties and the first retail outlet opened in 1988 (Niven, 2004b). The major benefit of the garden festival in Stoke was that it

increased the site's appeal for developers, which ultimately led to its redevelopment for a long-term after-use.

5.3.3 Festival Park: The Site Today

A significant portion of the gardens and park land have been retained and provide public open space but the out-of-town retail and leisure park is the most prominent land use. Elsewhere on the site there are offices, a large marina for narrow boats, a water park, a ski-slope, a cinema, a ten-pin bowling alley, and a toboggan run. There is also a hotel, which incorporates Etruria Hall, former home of Josiah Wedgwood founder of the famous Pottery factory. At the northern tip of the site, the large complex of festival greenhouses has been retained and these now operate as the City Council's plant nursery for the entire city. The site has been completely redeveloped and is now fully in use, and it provides a good example of a successful brownfield redevelopment project.

5.4 Glasgow Garden Festival 1988

5.4.1 Redevelopment and the Festival

The 60-hectare site of the Glasgow festival, on the south bank of the river Clyde west of the city centre, consisted of a disused dock and derelict industrial premises and was formerly Prince's Dock before it closed in the 1970s. Redevelopment was much simpler than at Liverpool or Stoke, as much of the site had already been cleared of heavy machinery. The major work was filling in waterways and channels with debris from the remaining derelict buildings (Theokas, 2004).

Over four million people attended the Glasgow festival in 1988, exceeding the target attendance by 400,000 but despite this it fell short of achieving target incomes from admissions (PACEC, 1990).

5.4.2 Post-Festival Redevelopment

After the festival, part of the site was developed to provide "expensive housing" but for almost a decade there was little interest from developers in the rest of the site (Lever, 1993). However, in 1995 Pacific Quay Development Ltd was formed as a joint venture company and redevelopment of the site finally proceeded. In the late 1990s the Glasgow Science Centre was built and this was followed by the Pacific Quays business park. The site is also being developed as a media centre including the Scottish Media Group's new headquarters which opened in 2006 and the new BBC Scottish headquarters due to open in 2007.

5.4.3 Pacific Quay: The Site Today

The site is best described as still undergoing redevelopment. The master plan for the site (Figure 32) includes the Glasgow Science Centre, IMAX cinema and '1 Pacific Quay' which have been completed and the BBC Scotland Building that is currently being constructed but a significant portion of the site is still waiting for development to start. It is also includes an area of park land which has been retained from the festival.

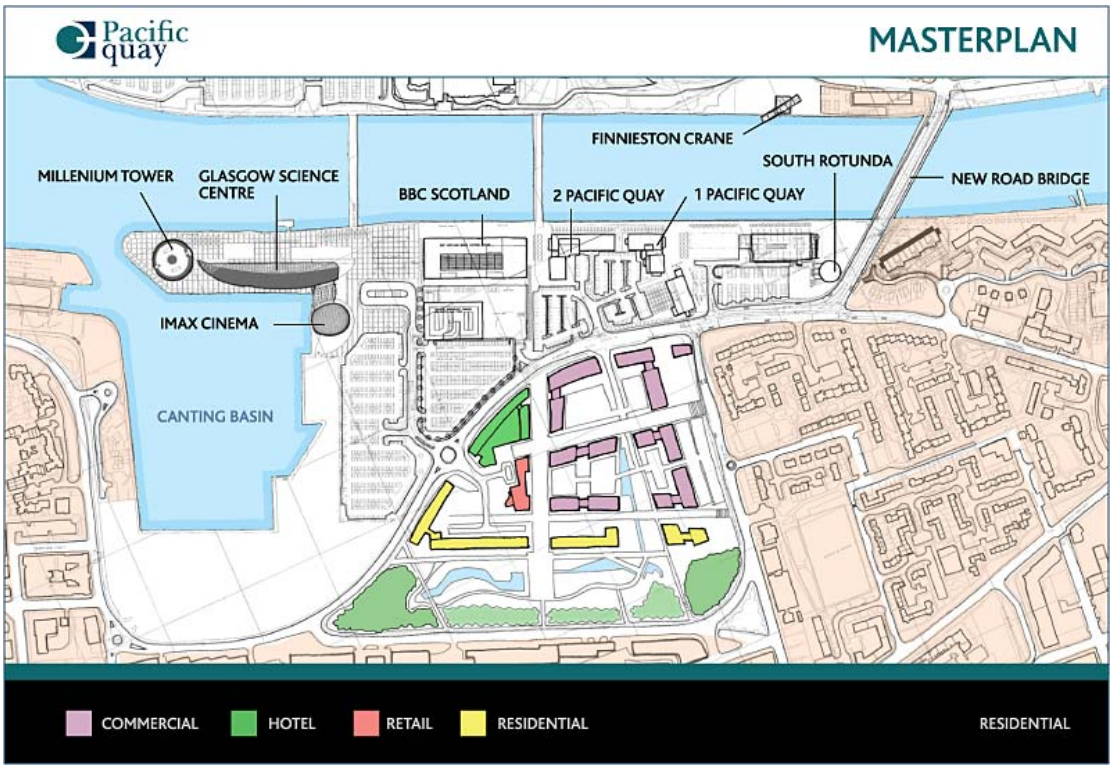


Figure 32: Site master plan (Source: Pacific Quay Developments, 2007)

5.5 Blooming success or wilted and forgotten: The long-term success of the National Garden Festivals

To evaluate if the National Garden Festivals constituted an appropriate option for the brownfield sites redeveloped, the long-term success of the National Garden Festivals will be analysed against two sets of criteria:

1. The objectives of the National Garden Festivals (see section 5.1), and;
2. The RESCUE definition of sustainable brownfield redevelopment (see section 5.5.2).

5.5.1 The Success of the National Garden Festivals

The National Garden Festival policy redeveloped large inner-city brownfield sites more rapidly than could have been expected by market forces alone, albeit it for a temporary use. In Liverpool, redevelopment took only 18 months and, prior to the

festival designation, the site had been included in the land to be redeveloped by the Merseyside Development Corporation (MDC, 1981; PACEC, 1990). In Stoke-on-Trent, the site redeveloped was the largest derelict site in the West Midlands and was likely to have been redeveloped over a 25-year period without the garden festival (Titchener, 1995). Following the festival the sites were available for redevelopment and in a much better condition than they had been. However, this did not prove sufficient to ensure they were redeveloped for a long-term after-use.

In Stoke, the festival organisation team was most active in preparing a development plan for the site and work took place during the run up to the festival to ensure that the site would be developed afterwards. In 1983, Stoke City Council granted outline planning permission for redevelopment of the site, setting out strategic objectives and development guidelines including the areas of permanent open space and areas available for development, and by 1985 a landscape framework for the site had also been approved (O'Connell, 1986). This was considerably more preparation for a long-term after use than had been carried out in Liverpool. However, in late 1986, the council was forced to publish a revised strategy following a lack of market interest and the council selected St. Modwen Properties to redevelop the site for a mixed use scheme, which was completed in 1995 (Niven, 2004b).

Two lessons can be drawn from the approach taken in Stoke. Firstly, if a site is going to be redeveloped for a long-term after-use having been initially redeveloped for a short-term interim use, it is vital that the long-term after use is considered in the planning process. Secondly, it is important that the planning process is flexible enough to respond to the prevailing market conditions: if the Stoke council had not amended its planning strategy, the site would have been unlikely to have attracted a developer. The consequences of a lack of planning are well illustrated by the Liverpool festival

site, where fifty hectares of the site remain derelict over twenty years after they were initially redeveloped. Without a longer-term vision, a short-term event is likely to have little benefit in terms of the long-term re-use of brownfield sites.

In Glasgow, the site was already subject to private sector development plans. However, the deal that saw the Scottish Development Agency lease the site for the festival saw these development plans relocated as the private developer was given access to seven other sites in Glasgow with permission for housing development. This ensured that a key riverside site remained available for mixed development.

The garden festivals were an early example of urban cultural tourism and provided a boost to the image of the host cities as they attracted large numbers of visitors that would not have otherwise visited. For example, the festival ensured that Stoke was the focus of national attention in the summer of 1986 (O'Toole and Robinson, 1990; Visit Stoke-on-Trent, 2007). The garden festival made a significant contribution to the long-term strategy in Glasgow to improve the image of the city, the 'Glasgow's Miles Better' campaign, which was designed to persuade Glaswegians that their city was improving and to promote the city to non-residents (Glasgow City Council, 2002). The festival improved Glasgow's image among UK visitors, served as a marketing tool for the city and played a role in the city's successful bid to become European City of Culture in 1990 (Booth and Boyle, 1993). The role that the garden festival played in the rise of Liverpool as a tourist destination is unclear as the festival was not incorporated into a campaign to improve the image of Liverpool city and has been overshadowed by the success of later projects, such as the redevelopment of Albert Dock. In summary, strategic planning ensured that the publicity and increased visitor numbers associated with the festivals helped to raise the profile of Glasgow and Stoke, whereas Liverpool failed to capitalise on this opportunity.

The garden festivals have been criticised for acting in an isolated manner rather than being integrated with other policies (O'Toole and Robinson, 1990). However, in Stoke, the National Garden Festival policy was not applied in isolation as the City Council and its partners embarked upon an imaginative redevelopment programme, to address the legacy of wide-scale mineral extraction, which provided new uses for over a thousand hectares of derelict land and brought the city much acclaim. The garden festival was seen as a celebration of the success of this program (Stoke-on-Trent City Council, 2003). The festivals could have had a greater impact if the redevelopment of the sites had been considered within a wider strategic framework. In the future, to ensure this happens, brownfield policies should consider individual projects within the context of regional strategies and national objectives.

Despite sharing the aim of reclaiming derelict land and returning it to beneficial use (an aim Liverpool and arguably Glasgow failed to achieve) each of the festivals had different objectives and these proved to have a significant impact on the long-term re-use of each site. In Liverpool the emphasis was placed on operational objectives, such as rapid redevelopment and horticultural aspects, which ensured a successful festival but reduced the chances of the site being redeveloped for a long-term after-use. The impact of this was that a large part of the site has not been redeveloped. In Stoke more emphasis was placed on quality and speed of redevelopment and conversion of the site for a long-term after-use which proved to be a successful formula, because redevelopment for the long-term use began in 1988 less than two years after the festival closed its gates to the public. In Glasgow more emphasis was placed on environmental improvement and the promotion of Glasgow's image, as well as ensuring the redevelopment of the site for a long term use. Although this strategy was successful in improving the image of Glasgow, the site took longer to secure

redevelopment and has required further public involvement (Scottish Enterprise, 2006).

The key lesson to be drawn from the National Garden Festivals is that it requires more than a one-off investment in tackling the environmental problems of a site to deliver brownfield redevelopment: to ensure this happens, early but flexible planning that integrates the environmental aspects of redevelopment with a long-term vision for the site is required.

Key objective	Liverpool	Stoke	Glasgow
Reclamation 1. Rapid reclamation of large derelict sites against a tight timescale	Yes	Yes	Yes
2. The reclaimed site should be of higher landscape quality and development than would otherwise be achieved	Probably	Probably	Probably
Environmental 3. Environmental improvement on site	Yes	Yes	Yes
4. The project should act as a spur for environmental improvements over a wider area	Unclear	No	Yes – other sites released
5. Longer term environmental benefits for the host town/city and its region, including 'image' effects	Unclear but seems unlikely	Yes	Maybe
Economic 6. Short-term economic benefits for the local area and its wider region due to construction work, operations and franchises associated with the garden festivals, and expenditure related spin-offs from visitors to the festival	Yes	Yes	Yes
7. Longer term economic benefits	No	Yes	No
8. Stimulation of landscape design and a showcase for the horticultural industries	Yes	Yes	Yes

Figure 33: Summary of the success of Liverpool, Stoke and Glasgow Garden Festivals in meeting the key objectives of the National Garden Festivals

5.5.2 The National Garden Festivals and Sustainable Brownfield Regeneration

Sustainable brownfield regeneration has been defined as:

> "the management, rehabilitation and return to beneficial use of the brownfields in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations in environmentally sensitive, economically viable, institutionally robust and socially acceptable ways within the particular regional context." (RESCUE, 2004b)

To determine if the garden festivals can be considered to be sustainable brownfield regeneration the Liverpool and Stoke festivals will now be evaluated against this definition.

In Liverpool, focusing on the main festival site, little direct and attractive benefits have been achieved for the stakeholders within the affected region due to the after-use of the site. Some benefit has been achieved through the clean-up of a contaminated site but due to the relatively recently closed landfill there is still potential that the site may be contaminated. The festival itself satisfied a number of both basic and higher human needs but as the re-use of the site was only temporary the site has not fulfilled human needs in the longer term. Parkinson and Evans (1988) argue that the special government initiatives in Liverpool (of which the garden festival is an example) failed to deal with the consequences of the economic decline in Liverpool, and although this is not a failing of the garden festival per se, it does highlight a failing of the policy making process to tackle the underlying problems associated with urban decline. The redevelopment of the site only provided a short term use and the planning process did not sufficiently consider the long term re-use of the site, meaning it has failed to be sustainable in the short and medium term. In the future, the site may be redeveloped for a long-term after use, but this will not have been as a result of the garden festival although the site remediation carried out for the festival may facilitate it. There is no evidence that the redevelopment was carried out in such a way as to minimise the

environmental impacts of the development but it did seek to improve the biological diversity of the site by providing open spaces. The institutional structure involved with the project seems to have been far from robust as there has been a lack of coordination between local government, central government and private developers on the site. In the authors opinion, the festival was not socially acceptable redevelopment based on the RESCUE definition of socially acceptable redevelopment: a redevelopment that meets the actual needs of the communities in the region (RESCUE, 2004b). Liverpool was suffering from severe deprivation which had led to rioting in 1981, months before the awarding of the festival. The central government response to this was the awarding of a short term project without any long term future, which offered a minimal number of jobs and failed to tackle the root causes of the deprivation. The Government response, in essence, was to send flowers to apologise for the Toxteth riots, rather than tackle the complex socio-economic causes.

The festival was developed by the Merseyside Development Corporation which had a budget of £30 million to regeneration only 350 hectares of land, where as the city council had only £37 million to spend on the rest of Liverpool. In addition the Merseyside Development Corporation was responsible to central rather than local government, so it is arguable that the redevelopment was in fact removed from the regional context rather than within it.

In Stoke, a long-term after use has been developed, and continues to thrive, that is likely to provide for a variety of human needs. As the redevelopment of the site took an area of brownfield land and converted it into a valuable asset that to date has provided leisure and other services, it can be said to be meeting the needs of the current generation but the ability of the redeveloped site to serve the needs of future generations is more difficult to assess. The environmental sensitivity of the

redevelopment is also difficult to assess due to a lack of information but in some respects it has improved the quality of the on-site environment, such as the development of open space and the remediation of the site. As the site has remained in use this suggests that the after-use provided by the redevelopment was economically viable. As the redevelopment was carried out by private developers within a framework developed by the local council the institutional structure appears to have been more robust than was the case in Liverpool. The redeveloped site appears to have met at least some of the genuine needs of local people otherwise the retail and leisure facilities would not continue to operate and from this respect it appears to be socially acceptable. The site was the largest derelict site in the West Midlands so its redevelopment is likely to have had some regional effect but there is insufficient evidence to determine if the redevelopment was carried out in such as way as to integrate it into the regional context, or if it contributed to the regeneration of the surrounding urban areas. Overall, from the evidence that is available, the redevelopment of the Stoke site seems to more closely meet the definition of sustainable brownfield regeneration than the redevelopment of the Liverpool site.

5.5 Summary

This chapter has assessed the success of the National Garden Festivals policy at securing a long-term after-use of brownfield sites in urban areas and found that only the site in Stoke has been fully redeveloped and returned to use, that part of the Liverpool site is still a brownfield today and in Glasgow redevelopment for a long-term use is underway, but has yet to be completed.

A number of lessons can be drawn from the successes and failures of the policy. In particular, we can see from Glasgow and Stoke that the interim use of a brownfield site can, if incorporated into a long-term strategy, help to improve the image of a city.

However, the objective of the policy was to return brownfield sites to use and in this respect, Stoke was the most successful of the three festivals. In essence the festivals proceeded along two lines: in Liverpool and Glasgow the policy represented a one-off investment to tackle the environmental problems of a brownfield site, an approach that failed to deliver redevelopment for a long-term use, whereas in Stoke a more integrated planning approach was taken that linked the physical aspects of redevelopment with the planning and development process, an approach that ensured a developer was found to return the site to a long-term beneficial use.

In summary, the policy was not very successful in terms of brownfield redevelopment but it did tackle the environmental problems of large areas of derelict land using an innovative strategy that brought much needed publicity to run down urban areas. However, it is likely that the rapid remediation meant that the sites were not made suitable for a long-term after use potentially contributing to the problems of the sites.

Chapter 6: An Urban Simulation Approach to Assess Brownfield Redevelopment Options

The aim of this chapter is to establish whether urban simulation can determine the most appropriate redevelopment option for a brownfield site by simulating the impact that redevelopment will have on the surrounding urban area. Carrying out an analysis of redevelopment options using an urban model could facilitate the selection of an after use policy from among alternatives (see chapter 1 and section 4.3.2) and can also be used to explore the potential for unforeseen consequences to occur.

6.1 Urban Simulation as an Analysis Tool

Urban simulation is the use of computer models to represent an urban area. Models can be divided into two broad categories: models of urban dynamics and urban visualisation models. The first category (from now on referred to simply as urban models), which are the focus of this chapter, simulate the dynamics of urban growth and development (Waddell and Ulfarsson, 2004). The second category simulate the urban visual landscape, usually three dimensionally (Shiode, 2001).

Urban models are operational models that combine theory, data and algorithms to represent urban areas (Torrens, 2000; Waddell and Ulfarsson, 2004). Torrens (2000) identifies a number of weaknesses with urban models:

1. As with any model, they are a simplified representation of a real-world phenomena;
2. The economic, social and environmental systems of urban areas are difficult to simulate, and;
3. The rapidly changing nature of urban areas makes it difficult for models to keep pace with the phenomena they are simulating.

Despite these difficulties, there are a number of reasons for applying urban models to the study of urban areas including concerns with the sustainability of urban land use policies and legislative pressure (Torrens, 2000). Legislative pressure is however more significant in the United States than in the UK, where there is little pressure to use urban models as part of the urban planning process. The main advantage of urban models is the opportunity to experiment with urban areas in a way that is neither possible nor necessarily desirable in the real world.

Urban models have been used to analyse the likely outcomes of plans and policies as part of urban planning in the United States since the 1960s when they were introduced as part of an effort to better quantify and represent the basis on which land use and planning decisions were made (Torrens, 2000; Waddell and Ulfarsson, 2004). However, much of the early the work focused on determining transportation needs generated by predicted land use patterns rather than considering alternative growth patterns (Waddell and Ulfarsson, 2004).

In the final decade of the 20th century, urban models began to shift from a narrow focus on road capacity expansion to a more integrated approach including multi-modal transport options, demand management and land use policies. Waddell and Ulfarsson (2004) argue that the shift occurred because:

1. It became apparent that the complex feedback mechanisms between transportation improvement, land use and environmental impact were not being adequately considered in existing models, and;
2. There was an increase in the range of policy options to address transportation and land use issues.

Urban models have been criticised for operating like a black box (i.e. the theory and implementation of the model is not available to the user) which can lead to a lack of understanding of how the results were obtained or their limitations, and in response have increasingly been built on clear and defensible foundations and have become more transparent (Waddell and Ulfarsson, 2004). As a result of these changes, urban models can provide a robust decision support tool for urban policy makers to assess alternative policy options and could provide the basis to determine the impact redeveloping a brownfield site will have on the surrounding urban area.

6.2 Criteria for a Model to Simulate the Impact of Brownfield Redevelopment on an Area

To establish if urban simulation can determine the impact of brownfield redevelopment, it is necessary to identify the criteria that an urban model must meet, identify the available models and assess whether the identified models fulfil the criteria.

A model is required that:

1. Is available within the constraints of this research, primarily in terms of time and finances;
2. Uses input data in the form of pre-prepared datasets rather than responding to 'real-time' user input;
3. Represents the process of development rather than just the allocation of land for development;
4. Is able to consider alternative socio-economic and transport scenarios, and;

5. Provides social, economic and environmental information as a basis for comparison between redevelopment options in a form that is available outside the model.

Furthermore, the representation of the process of development within the model is required to:

1. Include the redevelopment of brownfield sites;
2. Include the development of greenfield sites;
3. Include the redevelopment of sites that are in use;
4. Consider land use and planning policies;
5. Consider the financial viability of development, and;
6. Take account of environmental factors when calculating the cost of development.

6.3 Available Models

Two models, SimCity 4 and UrbanSim 3, met the screening criteria of being available within the constraints of this research and these will now be introduced.

6.3.1 SimCity 4

SimCity 4 is a simulation "God game" in which the player assumes the role of mayor of a city. The main component of the game, the 'mayor mode', is an urban model which represents the dynamic relationships between a city, including its population, the mayor (controlled by the player) and the environment (Artista and Hellweger, 2006).

The original SimCity was released in 1989, followed by SimCity 2000 in 1995, SimCity 3000 in 1998 and SimCity 4 in 2003. The series has been very popular with gamers and it has even been suggested that more cities have now been built in the

virtual world of SimCity than have ever existed in the real world (Johnson, 2002). As the series has evolved the games have become increasingly complex (Starr, 1994): for example in the original SimCity there was only a single tax rate but in SimCity 4 rates can be set based on land use, wealth and type of business. Almost every aspect of the game has seen similar increases in complexity and additional components of cities have been added to the game including public transport, environmental pollution, waste management and interactivity with neighbouring cities.

The model structure of SimCity 4 has not been published as learning how the model works is part of the challenge of the game. Therefore, the model operates like a black box and suffers from the same limitations as some earlier urban models (see section 6.1).

Its operation consists of two parts: the player controlled aspect of the game and the dynamic model of the city. The former consists of the player acting as mayor and town planner by assigning land use zoning, providing infrastructure such as roads, public transportation, power supply, water supply and waste disposal, and building public services such as schools, health care, emergency services and leisure facilities. The player also has financial and policy making roles which include setting tax rates and funding levels for public services, and enacting 'ordinances' or local laws regarding a range of issues, examples of which include free health care clinics, air pollution controls, tourism promotion and legalising gambling.

The dynamic model of the city represents the relationship between people, the natural environment and the built environment. Specific processes that are represented include:

Property development (what buildings are built and where);

Locational choices of businesses (where businesses are set up);

Locational choices of people (where people choose to live);

Transportation systems;

The impact of the city on the natural environment including air, water and radioactive pollution, and;

The life of the citizens (e.g. where they work, their level of health and education). This is represented using residential buildings rather than individual people.

The representation of property development includes the construction of new buildings on undeveloped plots of zoned land and the redevelopment of existing buildings. The closest SimCity 4 comes to representing brownfield sites is through an interaction between the development model and the locational choice model in which buildings can become abandoned if they are left vacant for a long period of time. Buildings become vacant due to a lack of demand for the building type which can be caused by high taxes, excessive commuter distances (limited to residential buildings), a poor supply of labour (commercial and industrial buildings) or high crime (generally limited to commercial buildings only). SimCity 4 will only simulate the redevelopment of a derelict site for the same use it had before becoming derelict (i.e. it will only simulate an industrial site being developed for a new industrial use. However, it is possible for the user to introduce other redevelopment options by re-zoning the land, building a civic building on the site (for example a school), planting forest, building transportation infrastructure (such as a new link road) or creating public open space (such as a park).

The output of SimCity 4 takes the form of feedback to the player which includes an advisory panel of city officials, time series graphs (Figure 34), spatial data views (Figure 35), data on the status of individual buildings (Figure 36) and opinion polls.

This output data is not stored in files that are available outside of SimCity 4 and therefore, any record of the data would have to be created manually. Therefore, SimCity 4 does not meet the criteria as it does not provide output data in a form that allows the impact of different redevelopment options to be compared.

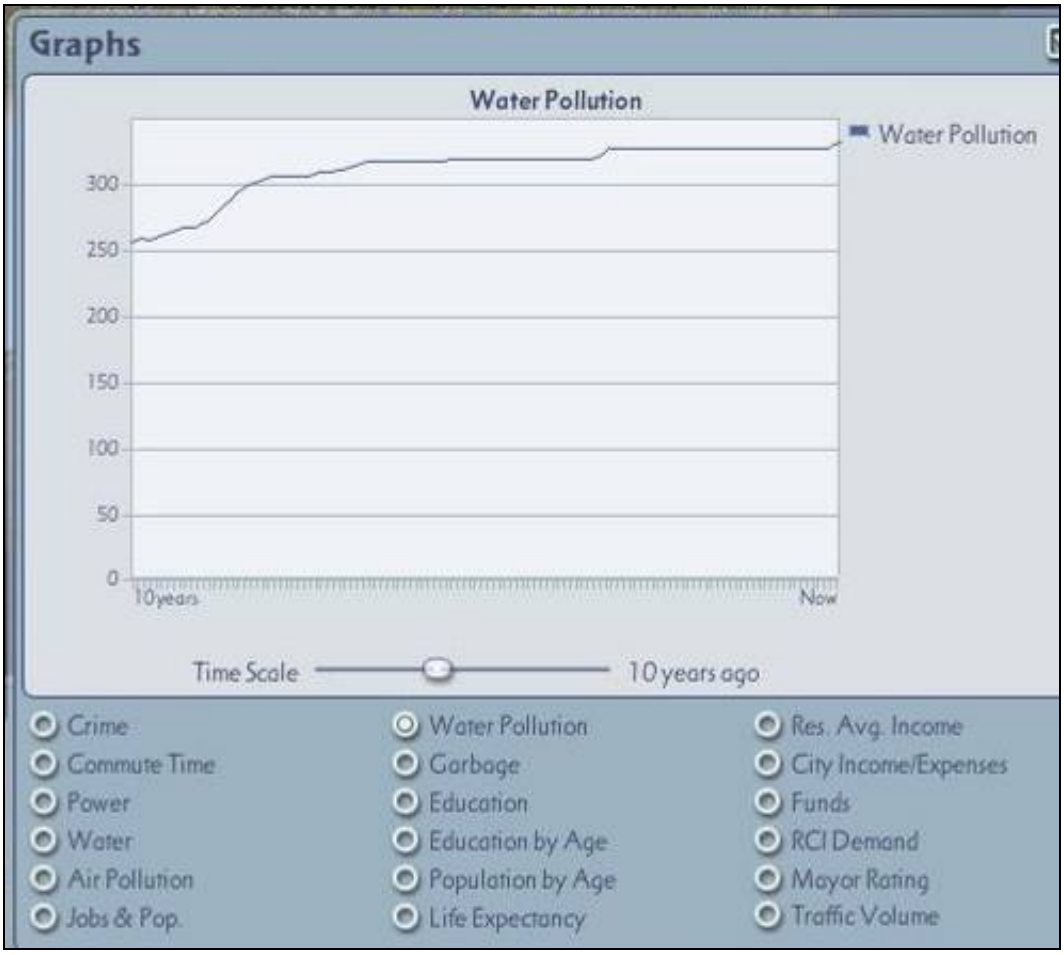


Figure 34: Example of a time series graph from SimCity 4 (showing a graph of the level of water pollution)

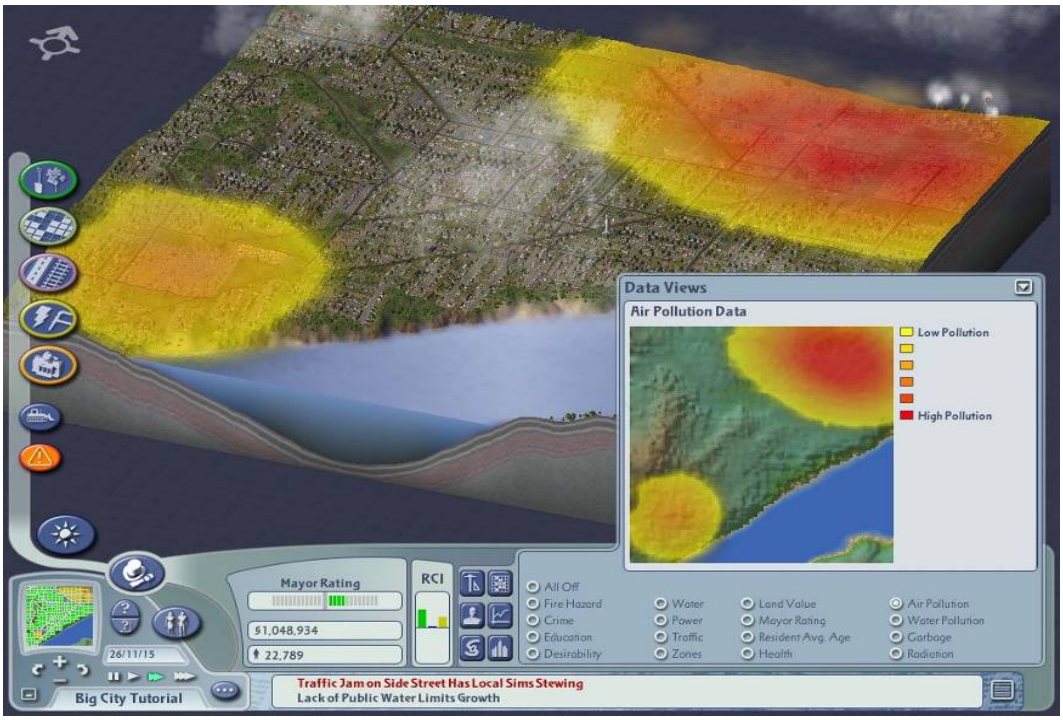


Figure 35: Example of a data view from SimCity 4 (showing data about the spatial distribution and level of air pollution)

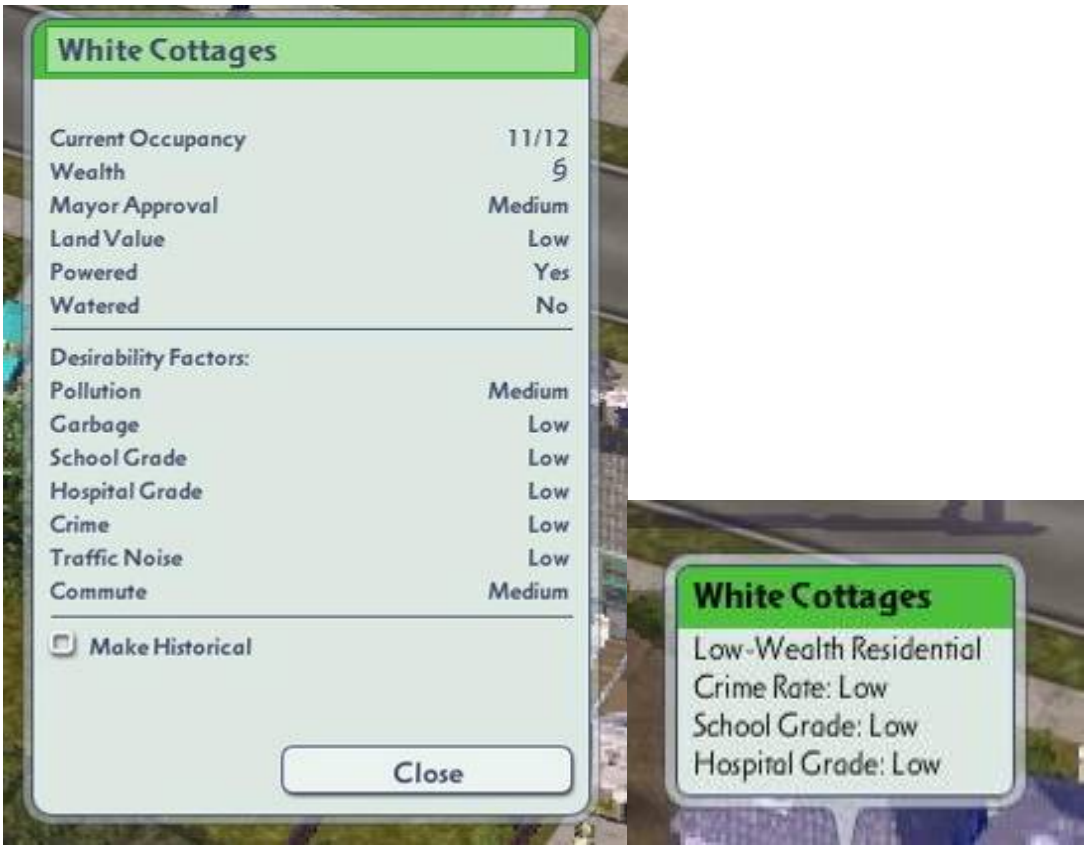


Figure 36: Two examples of data on the status of individual buildings in SimCity 4 (showing two different sets of data about a residential property)

6.3.2 UrbanSim 3

UrbanSim 3 is a large-scale urban simulator that models land use, transportation and environmental impacts over periods of twenty years or more. It represents urban development as the interaction between market behaviour and government decisions which makes it particularly suitable for assessing the impact of alternative land use policies. This approach to representing urban areas is based on the perspective that urban development results from the decisions made by actors, such as households, businesses, developers and policy makers, within urban markets for land, housing, non-residential space and transportation (UrbanSim, 2006).

UrbanSim was developed to provide a tool for integrated land use and transport planning at the metropolitan scale that was built on clear and defensible foundations (Waddell, 2001). The original UrbanSim model was developed for Honolulu, Hawaii, as a land use simulation model and was integrated with transport models as part of the Transportation and Land Use Model Integration Project (TLUMIP) (Waddell, 2002). The resulting policy analysis tool was validated using data from the Eugene-Springfield area of Oregon from 1980 to 1994 and has since been applied in other areas including the Greater Wasatch Front area of Utah, San Antonio, Houston-Galveston, Paris, Tel Aviv and Melbourne (UrbanSim, 2007b; Waddell et al., 2007). The model continues to be developed at the Centre for Urban Simulation and Policy Analysis at the University of Washington in Seattle (UrbanSim, 2006).

The major advantage of UrbanSim is that details of the operation of the model are openly available and therefore, UrbanSim does not operate like a black box. UrbanSim represents urban areas through a set of interacting models (Figure 37) including:

An accessibility model;

An economic and demographic transition model;

A mobility model;

A location choice model;

A real estate development model;

A land price model, and;

An export model (Waddell and Ulfarsson, 2004).

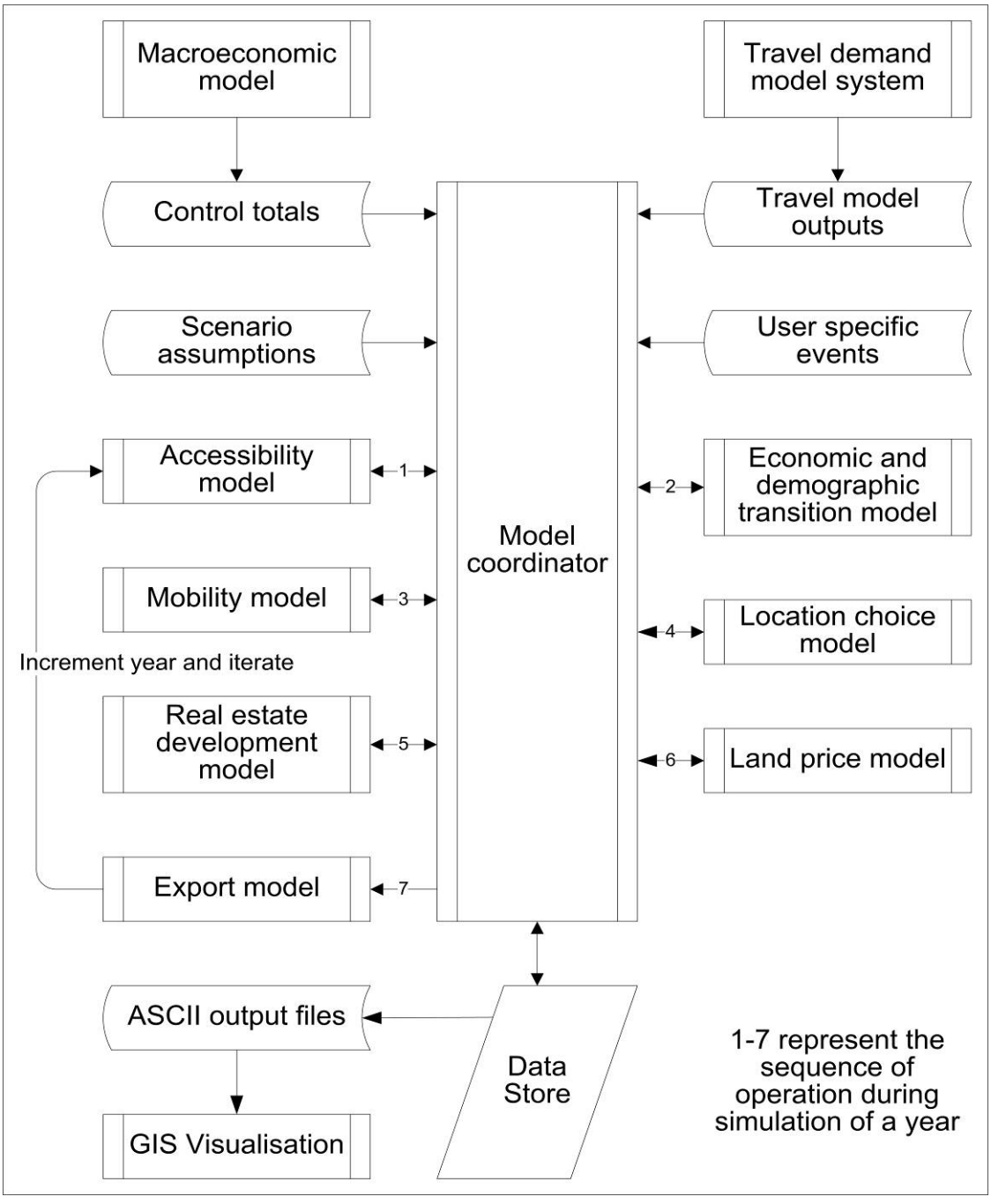


Figure 37: Structure of the UrbanSim model (Noth et al., 2003)

Control totals from the external macro-economic model, travel demand model outputs, scenario assumptions, base year data (including initial development type for each cell) and user specified events provide the user defined input to the model. The individual models represent the different processes and actors of the urban area, which are scheduled to run by the model coordinator. The model coordinator also notifies the individual models when their input data changes. Representations of the urban entities modelled are held in the data store which communicates with the models via a transition and aggregation layer (not shown in the diagram) (Noth et al., 2003). Noth et al describe this set up as 'modular software architecture' because each model is an individual module that can be replaced by improved versions. This means that UrbanSim can be updated as new versions of the individual models become available rather than having to update the entire model.

UrbanSim simulates the construction of new developments by predicting the probability of a grid cell (UrbanSim divides the area being modelled in to grid cells) experiencing a development event within a single simulation year (Waddell et al., 2003). It does this by simulating the probability of each possible transition from one development type to another, for every cell in the model database. The set of possible transitions includes a transition that involves no change (i.e. there is no development event in that cell for that simulation year) and if any other transition has a probability that is greater than that of the 'no change' transition then UrbanSim will implement the development. It does this using a development template to obtain the most likely characteristics of the development project within the cell including the number of dwellings and floor space of non-residential uses added. Development can be constrained within UrbanSim through a combination of spatial overlays (such as land use plan designations, floodplains or urban growth boundaries) and decision rules

about specific types of development allowed in different situations. For example, it would be possible to constrain development within a flood plain to only those uses permitted in PPS25 (see section 4.3.8) or to prevent any development in areas of high levels of biodiversity (see section 4.3.7). Decision rules can also be used to prevent transitions between development types. For example, it is possible to introduce a constraint that prevents any cell developed for dense industry being redeveloped for residential uses. UrbanSim estimates the probabilities of each development transition by analysing historical development events (which are part of the user defined input to the model) but does not identify events that involve demolition. Therefore, the developer model in UrbanSim only simulates development that is on vacant land or involves the intensification of existing land uses and does not simulate the creation of brownfield sites. Furthermore, the development types do not include a type to represent brownfield sites so it is not possible to overcome this by specifying cells that are brownfields as part of the base year data.

UrbanSim is intended for a variety of users and uses but setting up the model for a new location is an involved process. This is because the input data takes the form of database files that must be prepared using information derived from population and employment estimates, economic forecasts, transportation plans, land use plans and development policies. The model can run based on different scenarios that represent different policy options or different economic or demographic changes depending on how the model is configured and the assumptions that are contained within, or used to prepare, the input data.

UrbanSim provides data output as a series of database files. These files can be used to generate indicators which convey information about significant aspects of the simulation results or can be analysed in other computer programs, such as

Geographical Information Systems (Schwartzman and Borning, 2007). The output data from UrbanSim includes:

Future year distributions of population;

Households by type (e.g. income, age of head, household size, presence of children, and housing type);

Businesses by type (e.g. industry and number of employees);

Land use by type (user-specified);

Units of housing by type;

Area of non-residential space by type;

Densities of development by type of land use, and;

Prices of land and buildings by land use.

6.4 Evaluation of the Models against the Criteria

UrbanSim 3 meets all of the basic criteria required of an urban model (see section 6.3.2) to evaluate alternative land use policy options (

Table 14). SimCity 4 meets only two of the five basic criteria and therefore SimCity 4 cannot be used to evaluate alternative land use policy options. Unfortunately the representation of the process of development in UrbanSim does not include the redevelopment of brownfield sites (Table 15), and therefore, despite meeting all the other required criteria, UrbanSim cannot be used to evaluate alternative land use options for brownfield sites. In summary, neither urban model available for this research can be used to evaluate alternative urban land use policy options. Therefore, it has not been possible to test if an appropriate redevelopment option for a brownfield site can be determined by simulating the impact of different options on the surrounding urban area using an urban model.

Table 14: Evaluation of the models against the required criteria

Criteria	UrbanSim 3	SimCity 4
Is available within the constraints of this research, primarily in terms of time and finances	√	√
Uses input data in the form of pre-prepared datasets rather than responding to 'real-time' user input;	√	X
Represents the process of development rather than just the allocation of land for development;	√	√
Is able to consider alternative socio-economic and transport scenarios	√	X
Provides social, economic and environmental information as a basis for comparison between redevelopment options that is available outside the model.	√	X

Table 15: Evaluation of the representation of development within the model against the required criteria

Criteria	UrbanSim 3	SimCity 4
Model the redevelopment of brownfield sites	X	√
Model development on greenfield sites	√	√
Model the redevelopment sites that are in use	√	√
Consider land use and planning policies	√	√
Consider financial viability of development	√	?
Take account of environmental factors when calculating the cost of development	√	X

6.5 Summary

Although it would be highly desirable to analyse the potential impact of brownfield redevelopment and to evaluate any unexpected consequences as part of the options appraisal process for the redevelopment of a brownfield site (see section 4.3.2) it has not been possible to identify any models that represent the dynamics of the creation and redevelopment of brownfield sites and provide data that could be used to compare the impact of different options. UrbanSim represents the dynamics of urban growth and change but does not consider brownfield redevelopment as part of the representation of these processes; possibly due to the simplification that has taken place to develop the model. SimCity 4 could be used to simulate the impact of

redevelopment but does not provide data in a format that would facilitate the comparison of different options. These short-comings must be overcome before they could be used to assess brownfield regeneration policies and truly reflect urban land management.

If these barriers could be overcome then urban simulation could become a tool to assist the development of Local Development Frameworks and other policies that influence the redevelopment options for brownfield sites. It would provide a means for making land use allocation decisions in a more robust evidence-based manner as the consequences of redevelopment options could be explored within the specific context of the site. It would also allow for a wide variety of options to be considered and compared. In short, it would allow experimentation to be carried out into the consequences of different options that is neither possible nor necessarily desirable in the real world.

For this to happen, it would require a concerted effort from the various bodies' involved (national and local government, regeneration agencies, academics and possibly the private sector) to develop or adapt a model to meet the requirements set out in this thesis and to make this available to those developing the policies together with the necessary resources (skilled practitioners, time and computer hardware) to carry out the modelling. However, without a policy requirement for land use policies to be supported by such computer modelling it seems unlikely that this will happen in the next few years.

Chapter 7: Brownfield REMIT/RESPONSE: A Systems Approach to Analysing Urban Brownfield Redevelopment

This chapter presents the Brownfield REMIT/RESPONSE method that has been developed to analyse the impact of urban brownfield redevelopment within the context of urban systems. This method considers the impact of redevelopment in an integrated and systematic manner rather than in an atomistic manner and by doing so provides a means to explore the full range of impacts caused by urban brownfield redevelopment (Table 16).

Table 16: A typology of impacts caused by urban brownfield redevelopment

Impact	Description
Perturbation	Change caused by redevelopment e.g. construction of new dwellings
Direct impact	Impact caused directly by the perturbation e.g. population increase caused by occupation of new dwellings
Secondary response	Response from the system resulting from any direct impacts e.g. increase in traffic caused by new population
Systemic response	Response caused by the operation of the system resulting from the original perturbation e.g. increase in road accidents

Traditional approaches to assessing the impact of development treat urban areas as simple systems, assuming that causes and effects are directly linked, and have not taken account of the complex and interactive nature of urban systems (Royal Commission on Environmental Pollution, 2007). Within complex and interactive systems, cause and effect are not necessarily linked in a direct or straightforward manner and simple changes can cause the system to respond in unexpected, and possibly undesirable, ways. For example, increasing household incomes can result in increased residential vacancy rates, lower property prices and possibly even abandonment of residential buildings (Grigsby et al., 1987). The method described

within this chapter provides a tool to assess the impact of different redevelopment options for a site as a basis for selecting which is most appropriate.

By applying a systems approach to brownfield redevelopment it treats the urban area as a system that will respond in a dynamic way to change. This allows thinking about redevelopment to move beyond considering urban areas as static systems where cause and effect are directly and simply linked and allows redevelopment to be considered in terms of activating a series of interlinked events that will have a variety of consequences. These consequences may not be apparent when considering the direct impact of development as they arise through the operation of the system.

The chapter begins with an introduction to systems approaches, their application to urban areas and the methods considered to model brownfield redevelopment, followed by an introduction to REMIT/RESPONSE and its operation. The final section describes the adaptation of the approach and proposes the Brownfield REMIT/RESPONSE method to assess the redevelopment of a brownfield site.

7.1 Applying a Systems Approach to Urban Areas

A system is a group, set, or aggregate of things (which will be referred to as components in this thesis), natural or artificial, forming a connected or complex whole (Oxford English Dictionary (OED), 1989b). A systems approach is one that treats the subject of the approach as a system.

7.1.1 Urban Systems

It is widely agreed that urban areas can be considered to be systems (Barney, 1974; Forrester, 1974; Leach et al., 1997; Wilson, 2000; Yoon and Lee, 2003; Sanders and Sanders, 2004; Royal Commission on Environmental Pollution, 2007). By considering an urban area as a system its complex and interactive nature to be taken into account

and how it responds to impacts can be explored. Understanding urban areas is a prerequisite to successful urban land management and a systems approach is considered to be a suitable means to gain this understanding (Alfeld and Meadows, 1974; Nathanail, 2005). Within this research it is considered that a systems approach provides a method to understand how the redevelopment of a brownfield site interacts with, and impacts upon, the surrounding urban area which can be exploited within the management of post-industrial urban areas. By considering the impact of different redevelopment options it is possible to assess how successfully each option meets the project objectives, and therefore which is the most appropriate redevelopment option for a site.

7.1.2 Systems Approaches That May Be Applicable To Brownfield Redevelopment

To assess the potential consequences of urban brownfield redevelopment a method is required to:

1. Identify the relevant components of the system formed by the site and the surrounding urban area within the context of the redevelopment;
2. Model or predict how the system behaves, and;
3. Predict how the system will respond to perturbations.

Three systems approaches, N^2 charts, Soft Systems Methodology and REMIT/RESPONSE, were reviewed to determine if they meet these criteria.

N^2 charts are a tool to record components and the relationships between them and can provide an overview of even the most complex systems (Hitchins, 2003). N^2 charts have been used to describe the relationships between a number of people or groups of people at an army barracks (Figure 38).

Commander CEO	Love Support Home	Friendship Information Advice	Orders Instructions Loyalty
Love Support Home	Wife	Hospitality	?
Friendship Information Advice	Respect	Commander / CEO's Colleague	?
Reports Respect Loyalty	Respect	?	Subordinate

Figure 38: N^2 Chart describing relationships at a barracks (After Hitchins, 2003)

This illustrates they how can be used to organise and present large amounts of information about a system or project in a simple and easily understood format. If the same information where presented using another system diagram, such as a causal link model for example (Figure 39), the operation of the system can become more difficult to comprehend.

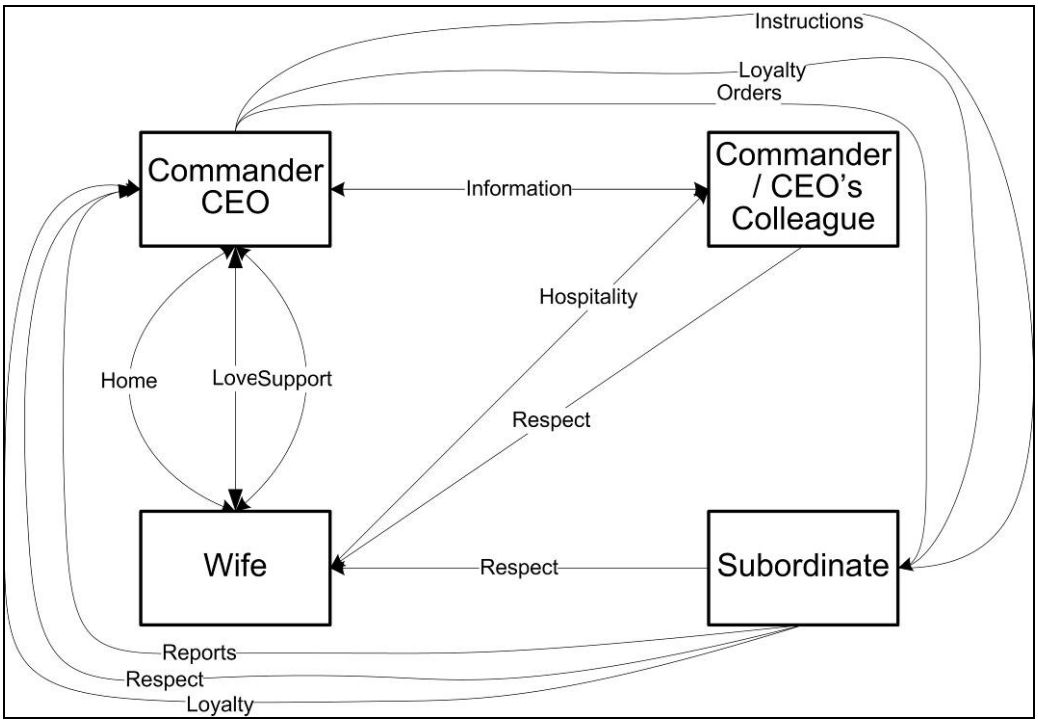


Figure 39: Causal Loop Model illustrating same system as Figure 38

However, although N^2 charts provide powerful tool for representing complex and interactive systems in an easily understandable way they provide no means to identify the components of a system, model how it behaves or predict how it will respond to

perturbations so do not meet the criteria set out above (i.e. they are a tool to present information not a method to model a system).

Soft System Methodology (SSM) involves a seven step process to apply systems theory to manage a situation (Figure 40) and includes the development of models of the situation (Checkland and Scholes, 1990). The methodology allows a systems approach to be applied to ill-structured situations which real life presents and solutions to be developed to guide the management of these situations (Checkland, 1981).

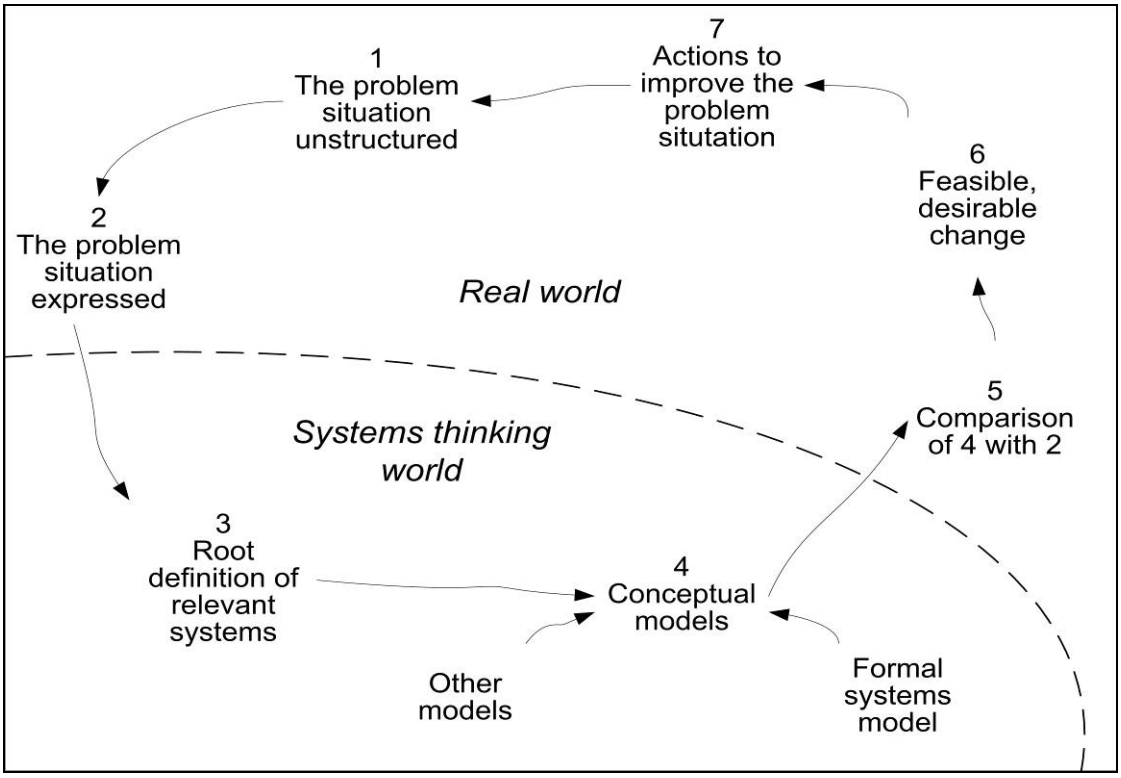


Figure 40: Soft systems methodology (After Checkland and Scholes, 1990)

However, the methodology has a number of draw backs which mean it is not applicable in this research. Firstly, the method provides a framework within which a model of the systems behaviour could be developed rather than a methodology to develop one and so does not meet the required criteria. Secondly, the methodology is intended to be applied to "human activity systems", which is defined as one that is carrying out human activity towards the achievement of a particular purpose or goal (Checkland, 1981). Urban areas are not purposeful in this sense, as the activity within

them is not focused on achieving a particular goal, and therefore the methodology is not applicable to urban regeneration.

SSM is generally applied to poorly defined systems to allow a dialogue between different stakeholders in order to agree an approach to solving a problem. Therefore, although SSM provides a means to think about brownfield redevelopment in a systematic way it does not provide a means to create the model of brownfield redevelopment that is required in this study. SSM may however provide a means of achieving agreement over the goals of brownfield redevelopment.

REMIT/RESPONSE is an objective-based systems approach that was developed to provide a means of understanding rock engineering problems holistically (Hudson, 1992; Hudson and Harrison, 1992) and was first applied to an open cast coal mining site in Wales (Nathanail et al., 1992). It has been suggested that REMIT/RESPONSE could provide a holistic approach to urban regeneration (Nathanail, 2005) and this research aims to determine if it can provide the basis for selecting the most appropriate redevelopment option for a brownfield site.

Table 17: Evaluation of the systems approaches reviewed

Criteria	N^2 charts	Soft systems methodology	REMIT/ RESPONSE
Identify the relevant components of the system formed by the site and the surrounding urban area	No	No	Yes
Model or predict how the system behaves	No	No	Yes
Predict how the system will respond to perturbations	No	No	Yes

7.2 REMIT/RESPONSE

REMIT/RESPONSE is a procedural approach to rock engineering that applies existing knowledge about a rock mass to develop a model of a rock engineering situation which can then be used to develop procedures to deliver stated objectives (Hudson,

1992; Nathanail et al., 1992). It was developed in direct response to the need for an all-encompassing procedural technique to approach increasingly complex rock engineering problems (Hudson, 1992). Traditional rock engineering approaches which attempt to produce exact representations of a rock mass are complicated to carry out for complex real-world rock engineering problems (Hudson, 1992). Traditional approaches can lead to an inaccurate model of the rock engineering problem as they do not include a procedure to ensure that all aspects of the problem are included and are unable to take into account the wider perspective of rock engineering (Hudson, 1992). REMIT/RESPONSE overcame these problems.

The approach relies on the premise that a system can be understood through the nature of the interactions between the principal components of the system (Nathanail, 2005). The idea being that you define a boundary for the problem and then develop a model of the system within that boundary. The challenge is to ensure that everything relevant within that boundary is present within the model. This is done by breaking the problem into component parts and then considering them as part of the system as a whole. The result is a model that provides an inexact representation of the system that includes all the relevant components (i.e. all the components are included but the components themselves, and the relationships between them, are not characterised precisely using mathematical formula).

Outside of rock engineering the approach has been applied to map traffic induced air pollution (Mavroulidou et al, 2004) and to contaminated land risk assessment (Johnson and Jardine, 1995)

7.3 The Operation of REMIT/RESPONSE

REMIT/RESPONSE involves a well-defined sequence of actions to develop a model of a situation or problem and then evaluate procedures to achieve stated objectives

(Hudson, 1992; Nathanail et al., 1992). The stages of the method, which combine to form its name, are:

1. ONSE (Objective-Based Network Sequence Evaluation);
2. RESP (Rock Engineering Systems Performance); and
3. REMIT (Rock Engineering Mechanisms Information Technology).

They are carried out in six steps which form the REMIT/RESPONSE methodology (Figure 41)

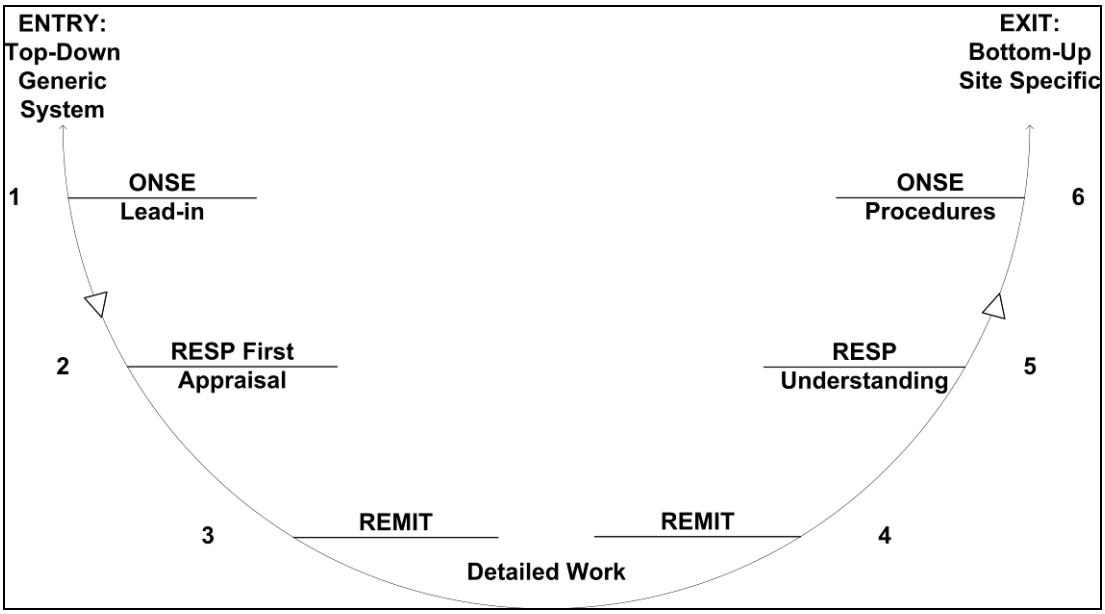


Figure 41: Generic REMIT/RESPONSE operation (After Hudson 1992)

7.3.1 Establishing the Objectives

The first step of the approach, ONSE lead-in, involves establishing what the rock engineering project is trying to achieve by addressing the following four questions (Nathanail et al., 1992):

1. What are the project objectives?
2. What are the explicit and implicit geotechnical objectives?
3. What are the constraints within which these objectives must be met?
4. Has the situation changed since the site objectives were set?

7.3.2 The Interaction Matrix

The interaction matrix, which is very similar in concept to N^2 charts (see section 7.12), was developed by Hudson (1992) to represent the behaviour of a system through the interaction of its components. In the interaction matrix, the main components of the system are represented as the leading diagonal terms and the interactions between them are described in the off-diagonal terms (Figure 42).

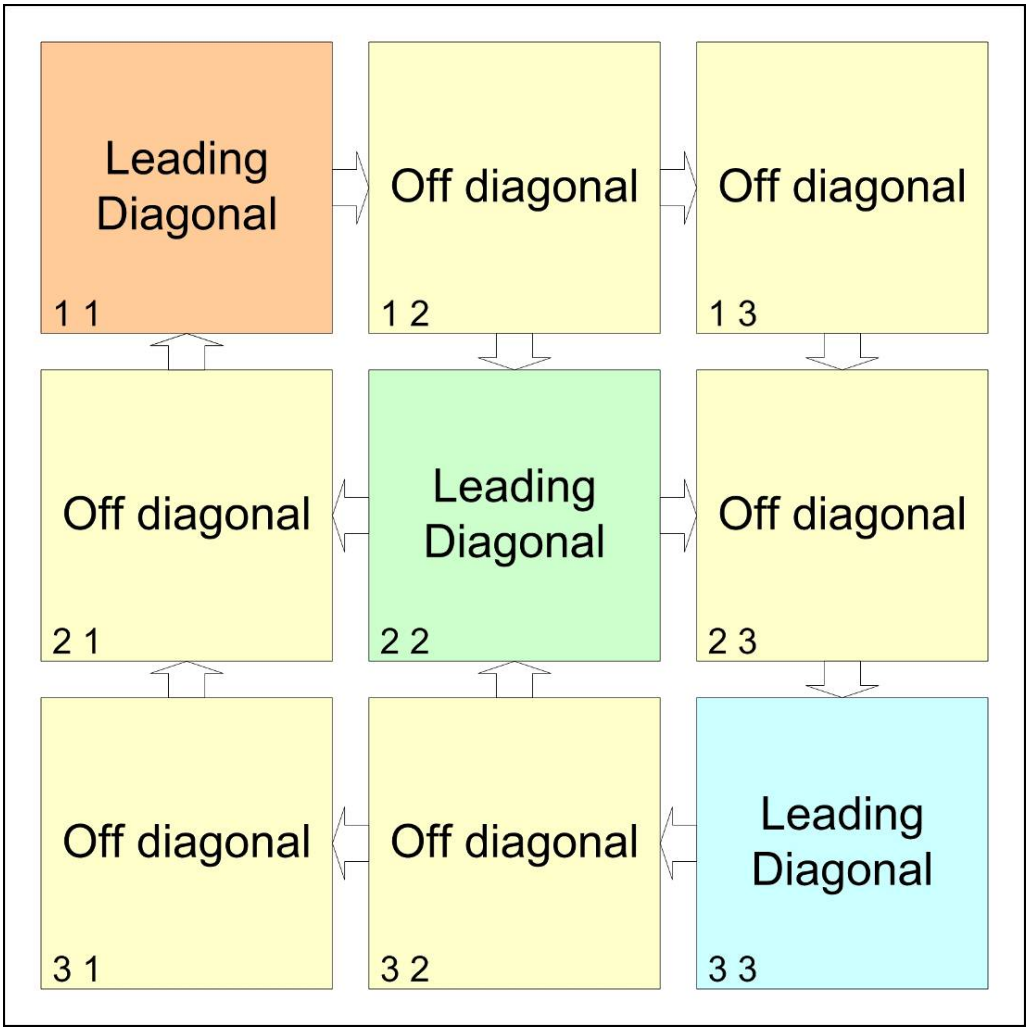


Figure 42: Leading diagonals and off diagonals of the interaction matrix

Each component is influenced by and in turn influences every other subject in the matrix, as shown conceptually below (Figure 43). It should be noted that the interaction matrix can be asymmetrical as the influence of A on B is not necessarily the same as the influence of B on A. Although the example below depicts a simple 2

x 2 matrix the concept can be expanded to contain any number of system components required (Hudson and Harrison, 1992).

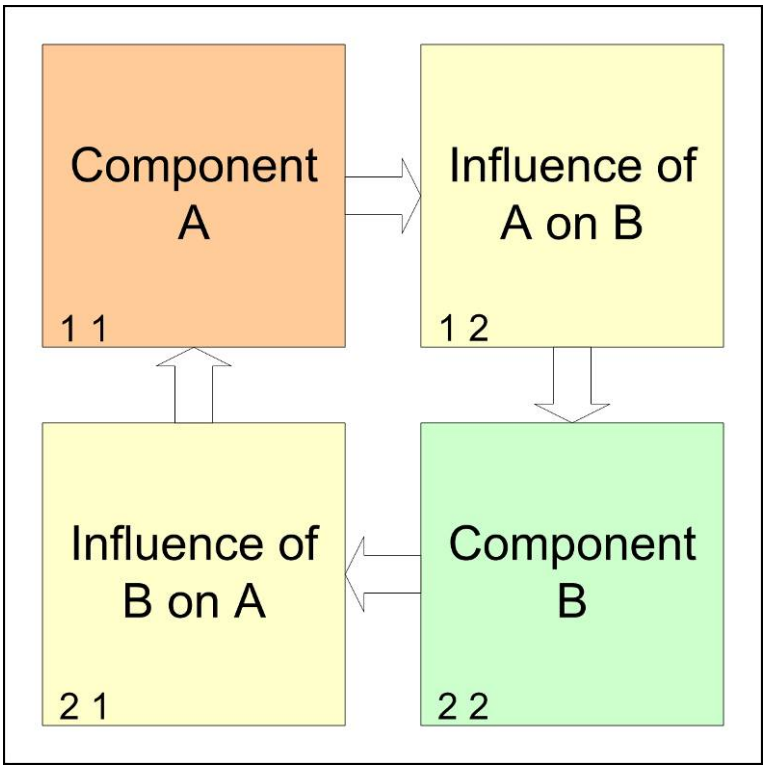


Figure 43: Conceptual representation of the interaction matrix

The example below (Figure 44) shows a matrix for a tunnelling project. Within this matrix rock mass structure, in situ stress, water flow and construction are considered to be the relevant components of the system (the leading diagonal terms) and the system behaviour is modelled as the interaction between them (the off-diagonal terms). Although the matrix considers the operation of the system in terms of direct relationships, through series of these direct interactions, it is possible the indirect secondary and tertiary influences that can arise (i.e. component A affecting component B which in turn effects component C).

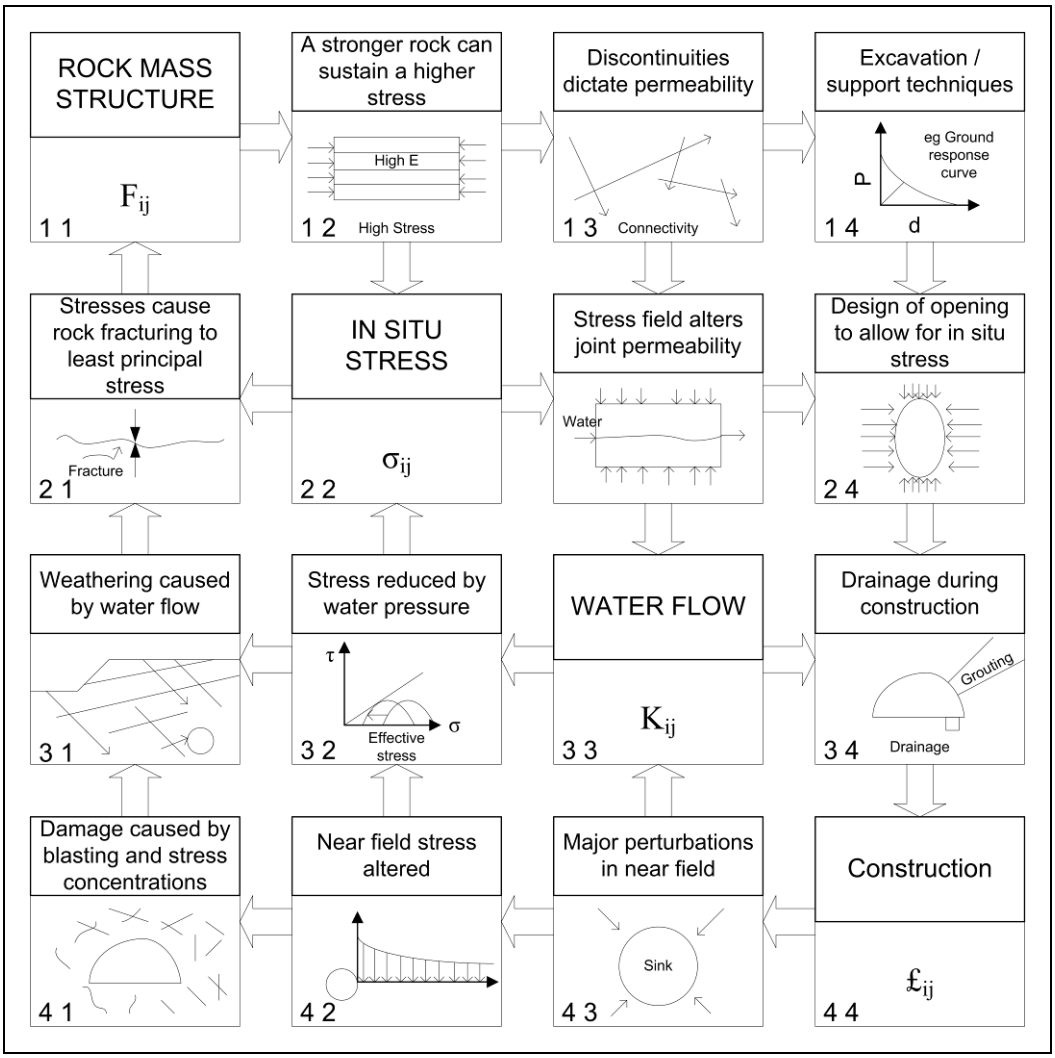


Figure 44: An interaction matrix for a tunnelling project through rock (After Hudson and Harrison 1992)

7.3.3 Identifying the Leading Diagonals

The second step, RESP first appraisal, involves identifying the relevant system components through an initial analysis of the project objectives, the nature of the site and the rock mass.

Hudson (1992) proposes that this is done using a process called "matrix winnowing" and "compacted reassembly". It begins by considering a coarse resolution model that represents the whole system in only three components – rock, site and project (Figure 45).

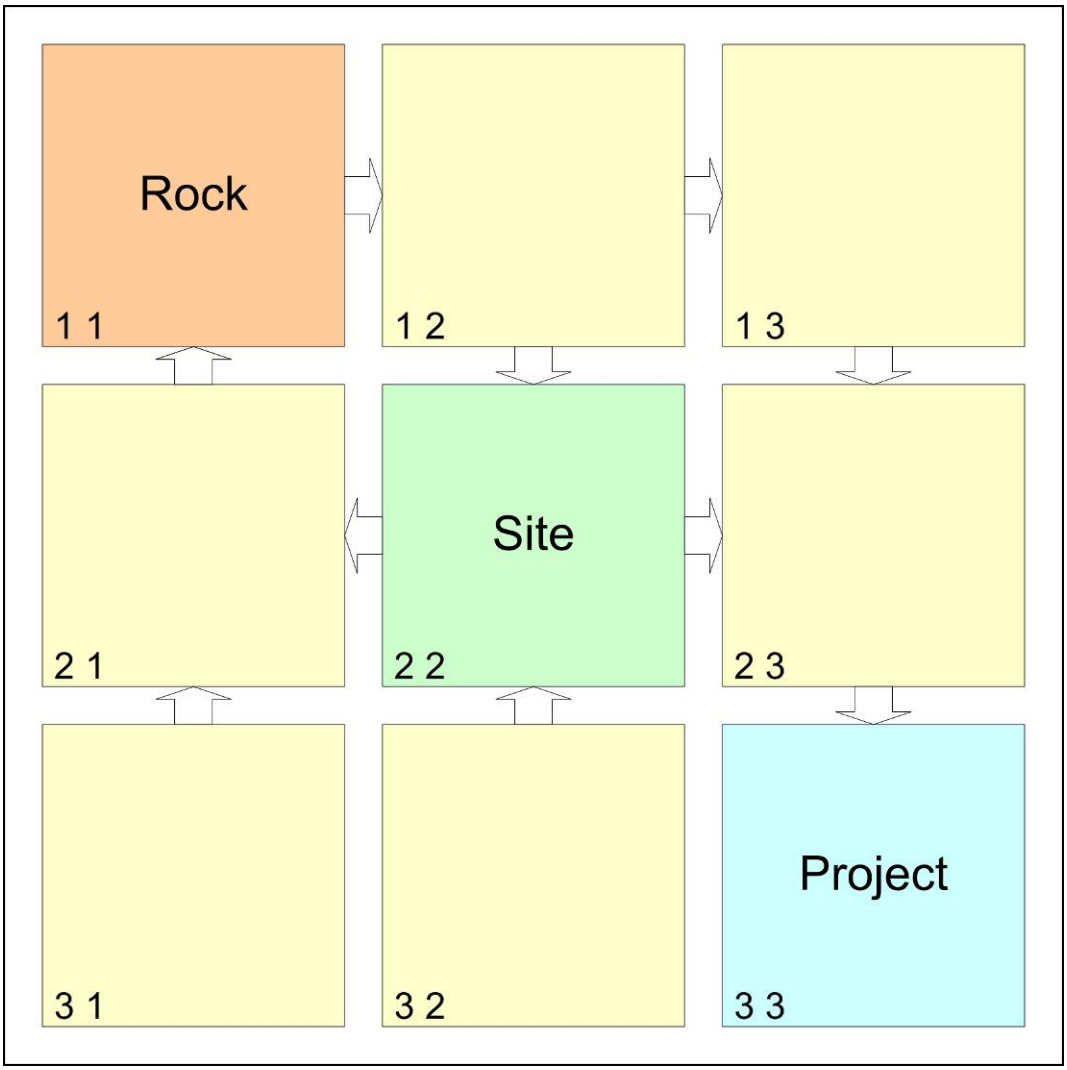


Figure 45: Coarse matrix with only three components (After Hudson, 1992)

The winnowing process is then started. Winnowing means to examine the system in order to select desirable components, and this is achieved by eliminating components that are not relevant. The importance of each component must be judged for its relevance within the context of the project that the matrix is being developed for. In the matrix shown above it is not possible to remove any components as they are all relevant. At the next resolution (Figure 46), it may be possible to remove components if they do not relate to project. For example, Hudson (1992) suggests we may be able to remove chemical sorption of particles onto rock fracture surfaces if rock slope stability is the objective of the project. The matrix resolution is then increased further

and components of the matrix are progressively removed if they are deemed to be irrelevant.

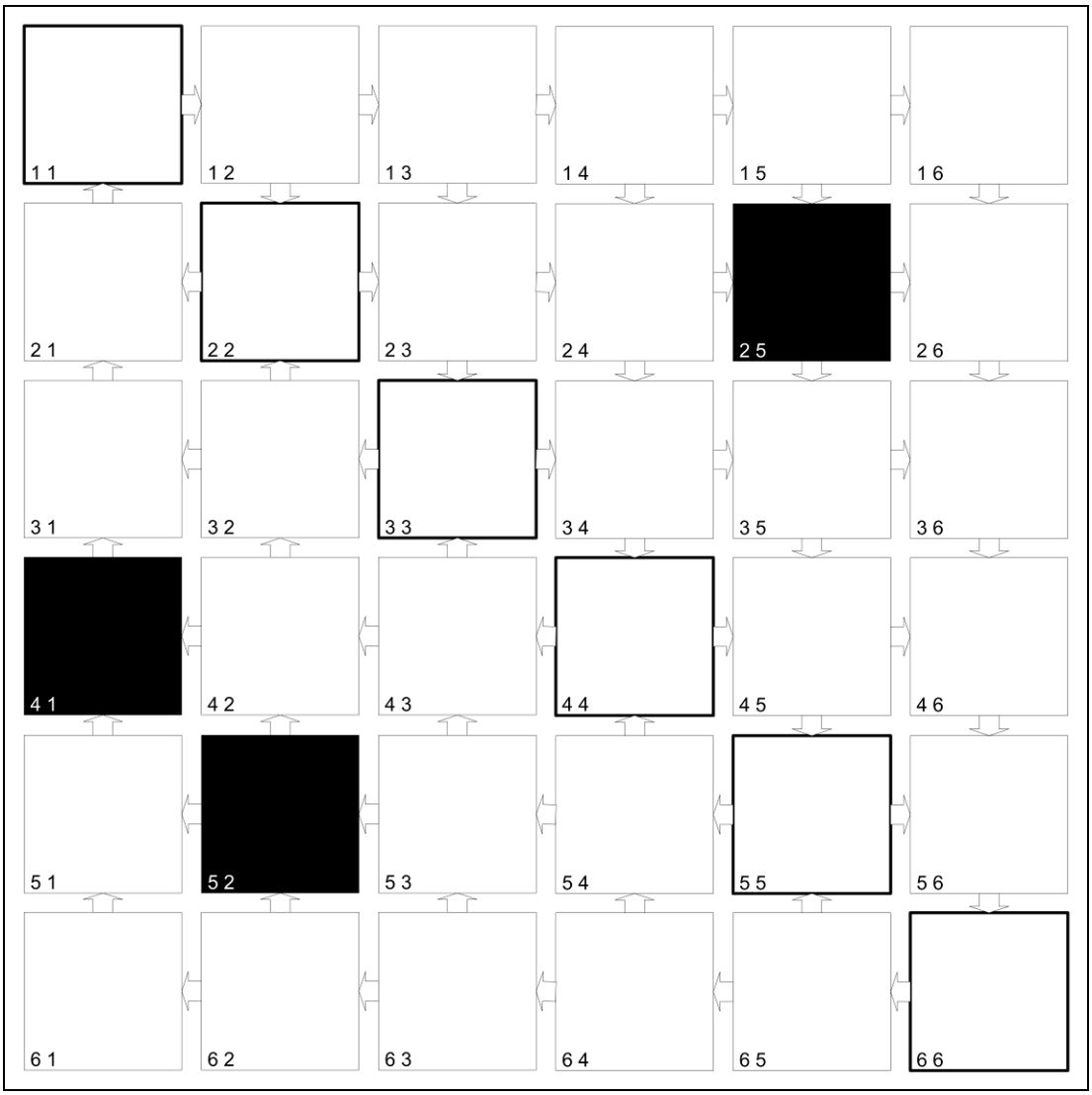


Figure 46: Intermediate resolution matrix (After Hudson, 1992)

After further winnowing, a matrix will be produced, which may be sparse for simple projects or quite dense for more complex projects. The components of the matrix then need to be reassembled to the required resolution for the specific project. The process relies to a significant degree upon engineering judgement which could introduce subjectivity into the method.

An alternative method of establishing the leading diagonals is the use of expert knowledge to select those components that are relevant given the project objectives. This method is less scientific in its application but can be carried out more quickly.

The output of this stage is a skeletal interaction matrix which lists the components of the system.

7.3.4 Analytically Modelling the Generic System

The third step, REMIT analysis I, involves describing how each component is influenced by every other component to produce a generic interaction matrix, or atlas of mechanisms, that describes the behaviour of the system (Hudson, 1992). The generic interaction matrix is developed by considering the interaction mechanism in each off-diagonal box and reviewing literature to identify how the relationship between the components can be described. The matrix may be incomplete if the relationship between some components is unknown. If it is not possible to identify a relationship between two components, it is assumed that there is no relationship between them. At this stage the matrix can be coded using the binary method to provide an indication of how many of the relationships have been identified and, therefore, how interactive the generic system is.

During this stage an analysis of the information needed about each component can be carried out by answering the following four questions (Hudson, 1992):

1. What do we need to know about the component?
2. What is known about the component?
3. Therefore, what do we not know?
4. How do we go about filling the gap in our knowledge?

The answers to these questions can be used to guide site investigation.

7.3.5 Analytically Modelling the Site Specific System

The fourth step, REMIT analysis 2, involves tailoring the generic matrix to the specific site and establishing how the components influence each other and the system as a whole through matrix coding (Figure 47) (Hudson, 1992).

To create a site specific interaction matrix the model of the system, as described by the generic interaction matrix, is considered within the context of the site being modelled. This involves assessing whether the mechanisms describing how the different components of the system interact are active in the urban system formed by the site and the area surrounding it. The matrix can then be coded to develop a model of the behaviour of the site specific system (Figure 47).

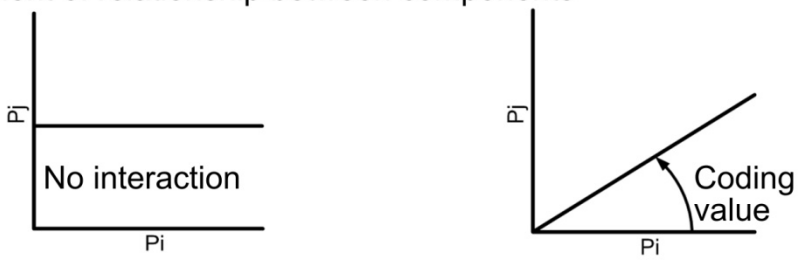
1	Binary – Mechanisms are switched on or off: (1,0)
2	Expert Semi-Quantitative (ESQ): 0 – No interaction 1 – Weak interaction 2 – Medium interaction 3 – Strong interaction 4 – 'Critical' interaction
3	Gradient of relationship between components 
4	Numerical solutions via partial differential equations
5	Numerical analysis of interaction mechanism

Figure 47: Matrix coding methods

It is worth noting that the choice of a scale of coding zero to four has no apparent theoretical basis, and the scale could, in theory, be altered (e.g zero to ten). However, for the purpose of this work the ESQ coding of zero to four will be adopted.

As the relationships between the components within urban areas are in general unquantifiable only the binary and expert semi-quantitative methods of coding are applicable to the study of urban systems (Jiao and Hudson, 1995) and therefore only these coding methods will be used in this research. The binary method allows a simple analysis of which mechanisms are active and this can be used to establish how interactive the matrix is. The expert semi-quantitative (ESQ) coding can be applied where the mechanisms cannot be quantified but an estimate of their significance can be made, and is therefore particularly useful where explicit mathematical relationships between components is not known or possible (Jiao and Hudson, 1995). However, it does require the user to assign a measure of how strong the interaction between each pair of components is opening up the method to subjectivity. There is no clear or obvious way of allocating the coding to the relationships but Hudson (1992. pp. 48) argues that once the user has carried out the method once or twice, the coding is usually definite.

Once the matrix has been coded the system can be analysed by evaluating how interactive and dominant each component within the system is (Figure 48). The row passing through a component represents the influence of that component on the system (cause or C) and the column passing through a component represents the influence of the system on it (effect or E).

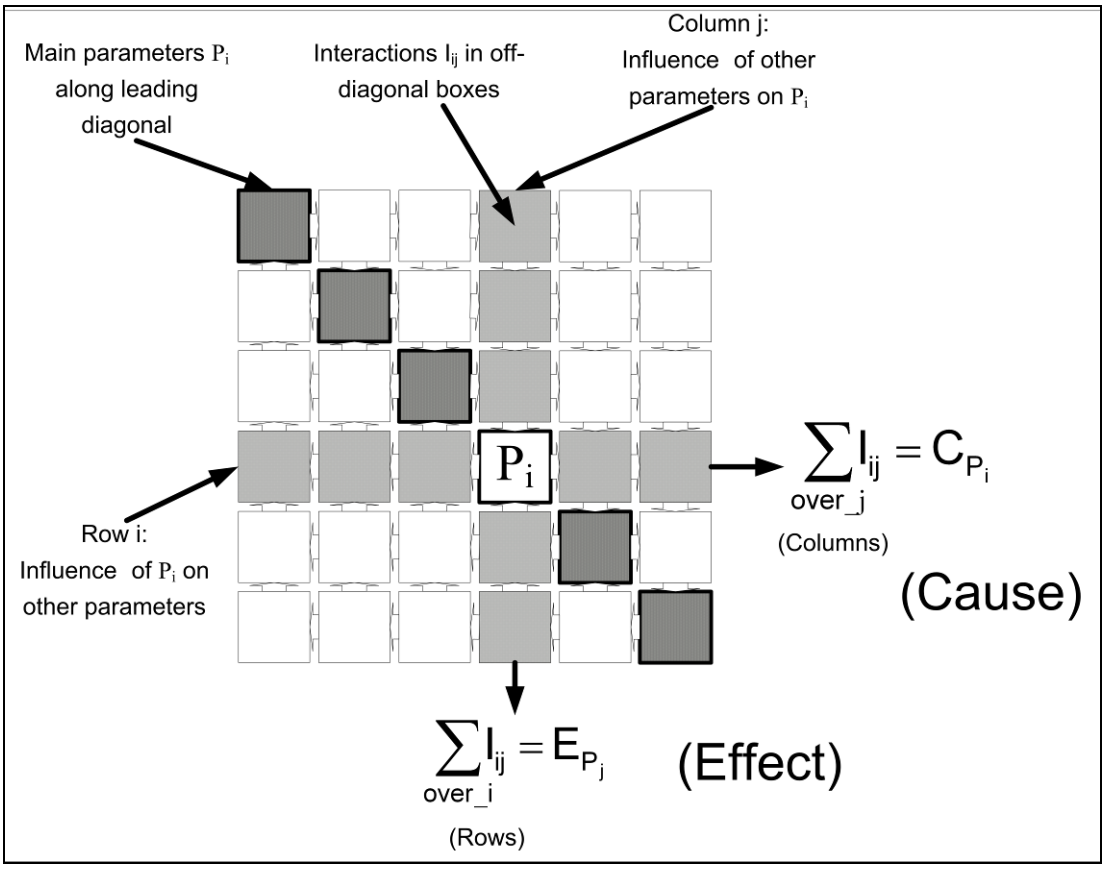


Figure 48: Generation of the cause and effect co-ordinates (after Hudson, 1992)

A plot of "cause" and "effect" scores for each component allows analysis of the system as it indicates how interactive the system is as a whole (Figure 49). The constellation formed by the plots of the "cause" and "effect" plots for the individual components will indicate the nature of the system. If the constellation is located close to the origin then the system is not very interactive, and if it is located further away from the origin it is more interactive. Perturbations to a highly interactive system are likely to result in a wider range of direct impacts, indirect and system responses than changes to a less interactive system. Therefore, the interactivity of the system gives an initial indication of how the system will react to the any changes introduced.

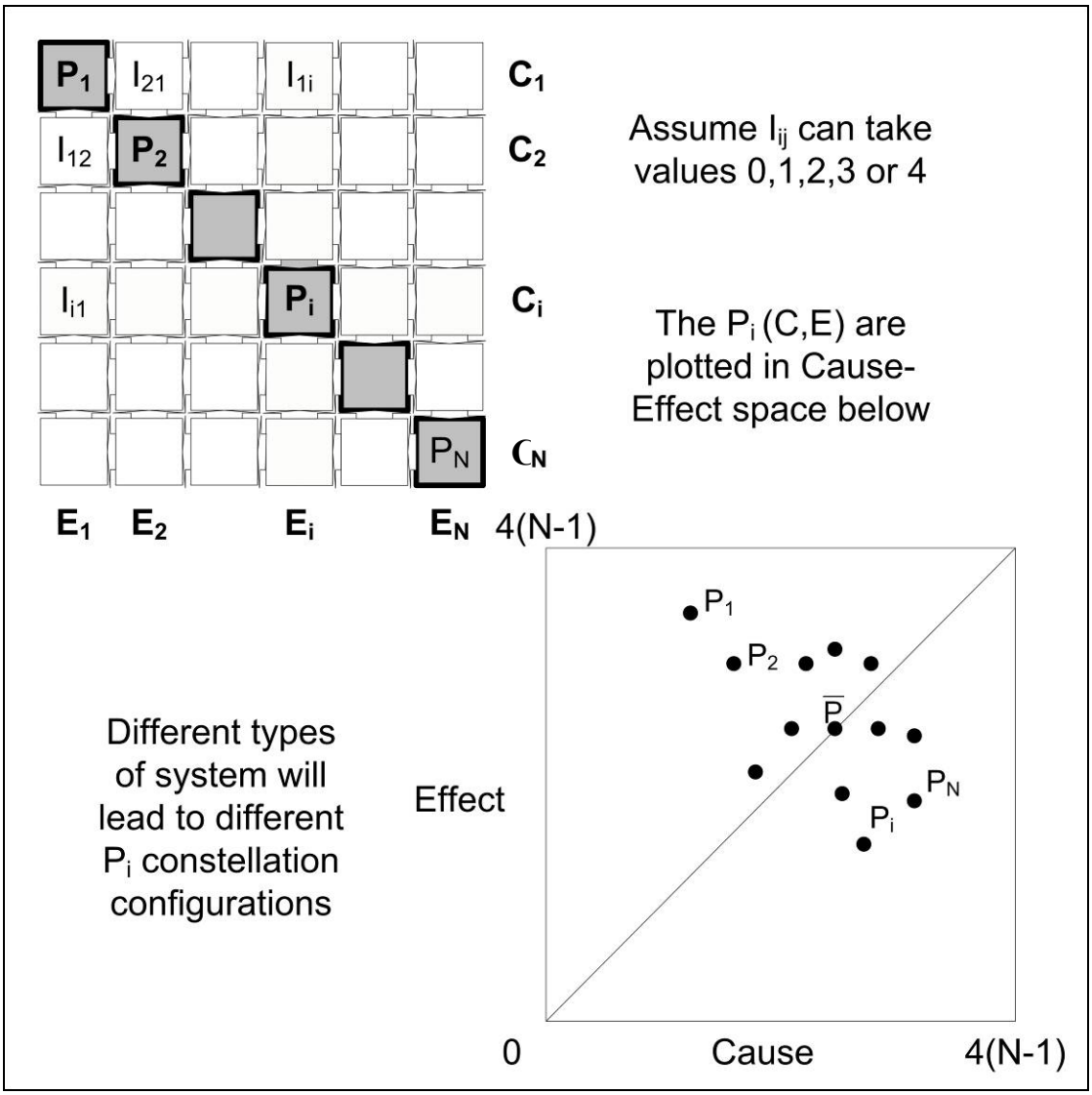


Figure 49: The C,E Diagram for N components (After Hudson, 1992 fig 4.8)

Individual component can also be analysed using the cause and effect diagram. If the component is plotted above the line of equal "cause" and "effect" the other components have a greater influence over the component than the component has over other components (it is subordinate). If a component is plotted below the line of equal "cause" and "effect" the component has more influence on other components than other components have on it (it is dominant). A component's interactivity can be identified by how far from the origin its score of "cause" and "effect" is plotted (along the line of equal cause and effect): the further from the origin the more interactive it is. The interactivity and dominance can also be calculated numerically, see Hudson (1992). The dominance and interactivity of an individual component indicates how it

relates to the other components and, therefore, how it is likely to respond to perturbations (see Table 16). A perturbation that affects a highly interactive and dominant component is likely to lead to direct impacts elsewhere in the system, which may then cause indirect and systemic responses. Alternatively, if a perturbation affects a subordinate component which has low interactivity, then less direct impacts are likely reducing the likelihood of indirect and systemic responses. A highly interactive subordinate component is likely to be indirectly impacted by perturbations to the system that do not directly affect it.

7.3.6 Establishing the Viability of Different Options

The fifth step, RESP understanding, involves the dynamic operation of the matrix by introducing perturbations caused by engineering operations and testing the impact that they have on the system. For example the consequences of excavating a particular sized tunnel or a change in groundwater level could be explored. This is done to develop an operational procedure, or set of possible procedures, that satisfies the project objectives and ensure the constraints are not breached.

7.3.7 Designing the Detail of the Project Procedures

The sixth, and final, Objective-based Network Sequence Evaluation (ONSE) procedures, involves the detailed construction design for the chosen operational procedure including monitoring arrangements.

7.4 The applicability of REMIT/RESPONSE to Brownfield Redevelopment

By reviewing Hudson's (Hudson, 1992; Hudson and Harrison, 1992) arguments for developing REMIT/RESPONSE and its relevance for rock engineering, it is possible

to demonstrate why a REMIT/RESPONSE based approach is suitable for assessing brownfield redevelopment options (section 4.3.2).

REMIT/RESPONSE was developed to meet the needs of rock engineering projects as they were becoming more complicated and needed to consider a wider variety of issues. Brownfield redevelopment projects have similarly become more complicated as sustainability issues have become more significant and greater emphasis has been placed on solutions that are integrated with the regeneration of the surrounding urban area (Ferber and Grimski, 2002; RESCUE, 2005). Furthermore, the aim of this thesis is to develop a method to select a redevelopment option for a brownfield site that considers a range of factors, not just economic viability that is currently considered as part of the options appraisal for brownfield redevelopment projects (see chapter 1 and section 4.3.2). A REMIT/RESPONSE based approach provides a means to assess the environmental, social and economic impacts of brownfield redevelopment in a holistic manner that can be tailored to the needs of a specific site, project and urban area, and therefore provides a means to achieve the aim of this thesis.

REMIT/RESPONSE was built on over thirty years of development within the field of rock engineering theory and was intended to tackle the problem that existing theory was not always used in the design, construction and monitoring of rock engineering projects (Hudson, 1992). Within brownfield redevelopment, although there is no coherent body of theory on brownfield redevelopment and regeneration, theory does exist but is spread throughout the literature of many disciplines and is generally not readily available to those who redevelop brownfield sites. A REMIT/RESPONSE based approach provides a means of synthesising this disjointed body of theory into a form that is readily available to those involved in the redevelopment of brownfield sites, the generic interaction matrix,.

REMIT/RESPONSE focuses on the complete system and Hudson argues that any rock engineering project must not only function in its own right but must also interface successfully with the rest of the scheme and with the rock mass as an engineering system. This is equally true of brownfield redevelopment, where not only must the site be redeveloped in its own right but it must also integrate successfully with the surrounding urban area if it is to contribute to urban regeneration. Therefore, a REMIT/RESPONSE based approach provides a means to consider brownfield redevelopment within its wider urban context.

Hudson argued that there was a need for a new approach to rock engineering that inherently incorporated the current knowledge base and could accommodate any rock engineering project objective. Similarly there is a need for a method that incorporates the existing brownfield regeneration theory and can accommodate any redevelopment or regeneration objective. Hudson suggests that REMIT/RESPONSE met this need for rock engineering and this research aims to demonstrate that a REMIT/RESPONSE based approach can meet this need for brownfield redevelopment.

There are also a number of other benefits to applying a REMIT/RESPONSE based approach to brownfield redevelopment. By considering brownfield redevelopment as a system it becomes possible to consider systemic effects (see Table 16), which are likely to be encountered in urban systems due to their complexity. Therefore, a REMIT/RESPONSE based approach could identify the impacts of redevelopment that arise through the sequential interaction of components of the system that would not be identified by considering the different aspects of the urban system in isolation. Brownfield redevelopment involves the integration of a number of different disciplines and processes including town planning, urban regeneration, environmental risk management, project management, construction and many others. Within each of

these disciplines there are theories, tools and methods, such as environmental impact assessment and masterplanning but these do not consider brownfield regeneration as whole. A REMIT/RESPONSE based approach provides an analytical framework for the complex multi-issue process of brownfield redevelopment that combines and integrates the separate aspects within a single coherent format. In other words, it provides an integrated approach that can be applied to analyse brownfield redevelopment in an integrated manner.

7.5 Brownfield REMIT/RESPONSE: A Systems Approach to Modelling Brownfield Redevelopment Projects

The final section of this chapter describes Brownfield REMIT/RESPONSE (Figure 50), a systems based approach to assessing the redevelopment of a brownfield site that has been developed by combining REMIT/RESPONSE with the six step process for developing an opportunity plan (see section 1.2). The method is intended to be applied to assess the redevelopment of individual brownfields within their urban context.

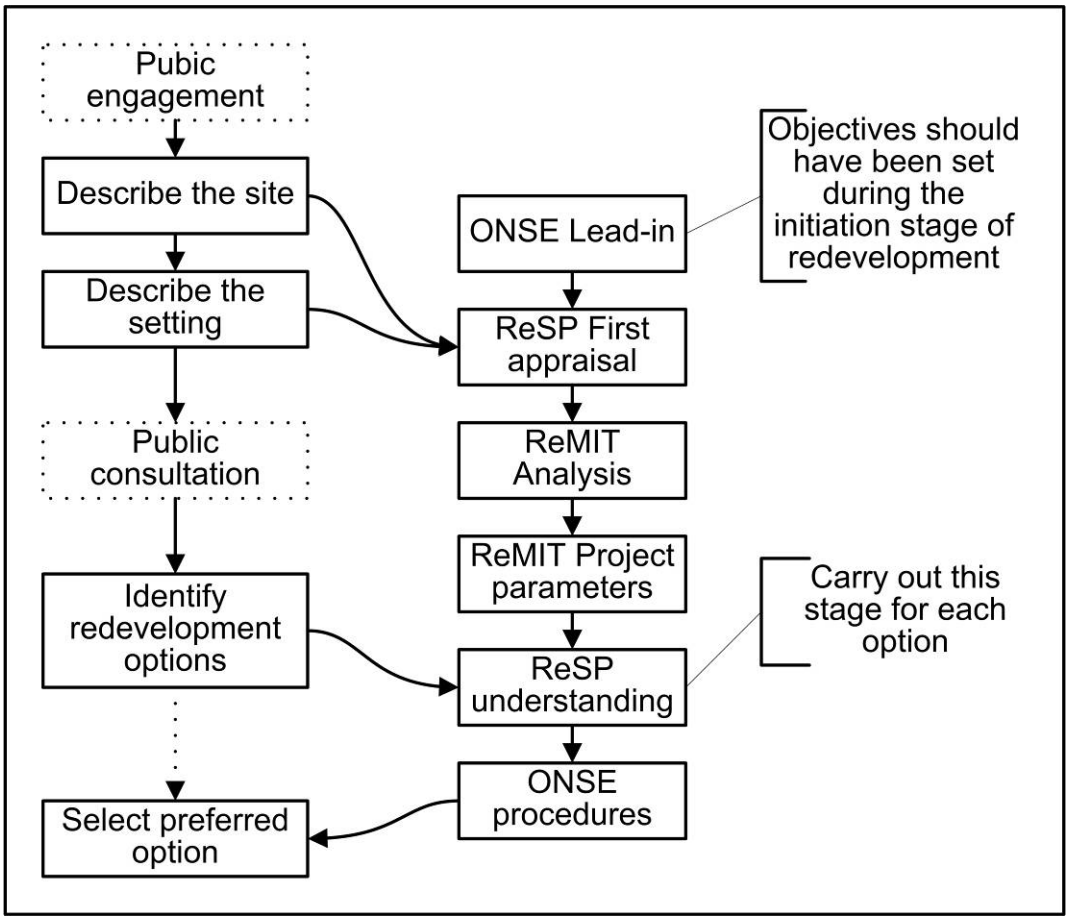


Figure 50: The steps in implementing Brownfield REMIT/RESPONSE Methodology

7.5.1 Translating REMIT/RESPONSE to Brownfield Redevelopment

In order to apply REMIT/RESPONSE to brownfield redevelopment the rock engineering aspects of the method must be adapted to fit their new context. In the original REMIT/RESPONSE the principal components of the system were:

Rock mass – the medium being altered;

Site conditions – the context, and;

Project engineering – the project.

In a brownfield redevelopment context, the principal components of the system are:

Brownfield site – the medium being altered;

Surrounding area – the context, and;

Redevelopment – the project.

The stages of the process also need to be adapted. The Objective-based Network Sequence Evaluation (ONSE) is not specific to rock engineering so does not need to be altered. Rock Engineering System Performance (RESP) will become Brownfield Redevelopment System Performance (ReSP) and Rock Engineering Mechanisms Information Technology (REMIT) will become Brownfield Redevelopment Mechanisms Information Technology (ReMIT) to reflect their application to brownfield redevelopment systems rather than rock engineering systems.

7.5.2 Describing the Site and the Urban Area

The first stage of Brownfield REMIT/RESPONSE is to describe the site and the surrounding urban area within the context of the proposed redevelopment. This can be done by collecting and analysing data about the site, the surrounding urban area and the proposed redevelopment from planning records, census data, policy documents, historic maps, site visits, environmental records, geological records, local studies libraries, "Landmark Information Group" Envirocheck data and the internet.

The outputs of this stage of the methodology are a conceptual model of the site, a description of the surrounding urban area and, if possible, a roadmap of the redevelopment process. This step is necessary to develop an understanding of the system (formed by the site, the surrounding urban area and the redevelopment proposals) required for the analytical steps of Brownfield REMIT/RESPONSE.

7.5.3 Assessing Brownfield Redevelopment using REMIT/RESPONSE

The analytical component of Brownfield REMIT/RESPONSE follows the steps of the original REMIT/RESPONSE (Figure 41). The first step is establishing the objectives of the redevelopment project by answering the following questions (Nathanail, 2005):

1. What are the site redevelopment objectives?
2. What are the wider regeneration objectives?
3. What are the constraints within which these objectives must be met?
4. Has the situation changed since the objectives were set?

Once the objectives and constraints have been established, the key components of the system can be identified by considering the site circumstances in terms of the project objectives. This will produce a list of components that will be the leading diagonals of the interaction matrix. The next step is to fill in the off-diagonal terms of the interaction matrix by investigating how each component interacts with every other component. This will produce a generic matrix, or atlas of mechanisms, which describes the generic operation of the system but has not yet been tailored to the specific site.

Once the relationships have been identified, the matrix can be coded using the binary method to identify which mechanisms are present and to allow analysis of the system (see 7.3.5). The output of this is a binary coded generic matrix that describes which mechanisms within the generic system are active.

The next step is to tailor the generic matrix to the specific site being analysed. This involves investigating each of the identified mechanisms within the context of the project. At this stage the expert semi-quantitative method (see Figure 47) can be applied to allow the strength of the relationships to be considered. This allows more detailed investigation of the interactiveness, dominance and dependence of the components. The outcome of this step is a site-specific coded interaction matrix that describes how the system operates at the specific site being investigated.

Once the operation of the site-specific systems has been described, redevelopment options for the site can be introduced to the system as a perturbation and the impact that each option has on the system can be assessed. This assessment can be carried out by applying an adapted version of the expert semi-quantitative method with a scale from -2 to +2, where -2 denotes a significant negative impact, -1 a minor negative impact, 0 no impact, +1 a minor positive impact and +2 a significant positive impact. However, care should be taken with this ESQ coding as the coding only gives an indication of the strength of an impact given the project objectives and particular care should be taken when identifying the cause and effect of a component. (for example two minor positive impacts are not necessarily equal to one major positive impact). As the site-specific coded-matrix describes how each component relates to each other component, a system perturbation can set in motion a chain of impacts that can be used to investigate the direct, indirect and systemic effects of redevelopment (see Table 16). The impact of redevelopment can be assessed against the project objectives and constraints to determine if the particular redevelopment option introduced to the system is appropriate. Each redevelopment option identified as part of the Opportunity Plan should be introduced to the system as a perturbation and assessed in this way. Once each option has been assessed, the results can be compared to determine which option best meets the objectives without breaching the constraints. The option identified is the most appropriate redevelopment option for the site (N.B. this is not necessarily the most appropriate redevelopment option possible but is the most appropriate of the options compared).

Once the most appropriate redevelopment option for the site has been identified, the redevelopment process (see chapter 4) can continue.

7.6 Summary

This chapter has introduced systems approaches in general and the REMIT/RESPONSE approach in detail. The main focus has been to explain why a REMIT/RESPONSE based approach could provide a suitable method to determine the most appropriate redevelopment option for a brownfield site. The chapter concludes with a proposal for a systems based tool, Brownfield REMIT/RESPONSE, to assess the redevelopment of a brownfield site. The application of this method is shown in the next two chapters.

Brownfield ReMIT/ReSPONSE provides a means for exploring the impact that brownfield redevelopment will have on the urban system within which it takes place and the exploration of the consequences that will arise as a result of these impacts. Therefore, it can provide a means for selecting redevelopment options based on a site specific analyse of the impact of redevelopment rather than relying on generic theories of redevelopment (i.e. building employment generating buildings will reduce local unemployment). In this way it provides a means to select redevelopment options using a robust evidence based approach.

Further more it provides a means to test the traditional theories of urban regeneration as it requires the regeneration outcomes attributed to a redevelopment project to be linked back to the redevelopment through a series of direct interactions between the component of the system.

Chapter 8: Applying Brownfield REMIT/RESPONSE to Brownfield Redevelopment

This chapter presents the application of Brownfield REMIT/RESPONSE to the Radford Goods Yard, Chettle's Yard and area site (the Radford site). It begins with a description of the Radford site, the Radford area and the redevelopment of the site. These are followed by the results of applying Brownfield REMIT/RESPONSE to the Radford site. The penultimate section of the chapter describes how policy influenced the redevelopment of the site and the chapter concludes with a summary.

8.1 The Radford Site

The Radford site (Figure 51) is a brownfield site that is currently being redeveloped. It is made up of four smaller sites (Figure 52) and the western part is included in the National Land Use Database as "PDL or buildings currently in use and allocated in the local plan or with planning permission". Table 18 provides a descriptive conceptual model of the Radford site.

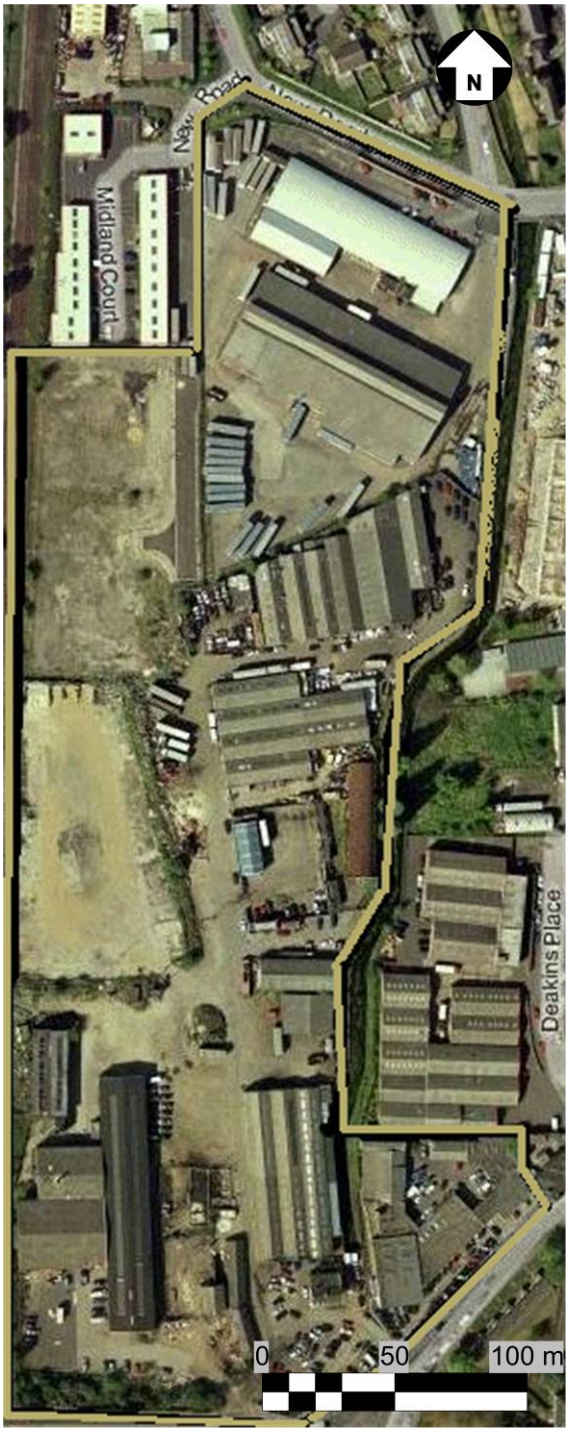


Figure 51: Aerial photograph of the Radford site prior to redevelopment (Source: Window Local Live)

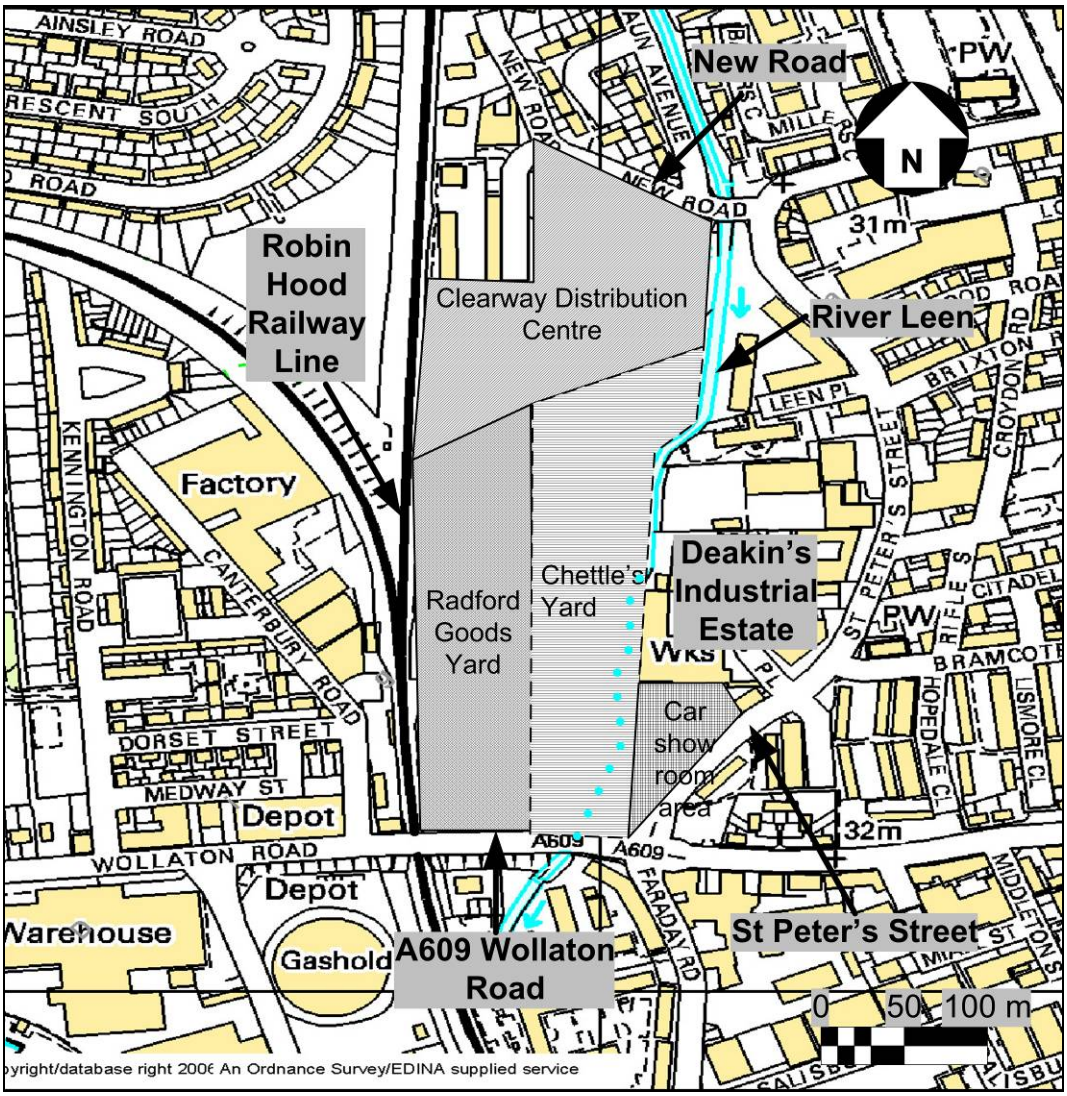


Figure 52: The four areas of the Radford site with former land use and site boundaries

Table 18: Descriptive conceptual model of the Radford site

Location (see Figure 53)	Old Radford, Nottingham 2 km west of Nottingham city centre
Local Authority	Nottingham City Council
Gross Hectares	6.1 hectares
Ownership	4 private owners
Site boundaries (see Figure 52)	Robin Hood Line railway (West) Wollaton Road (A609) (South) New Road (North) River Leen (Eastern boundary in the northern part of the site) St Peter's Street (Eastern boundary in the central part of the site) Deakin's industrial estate (Eastern boundary in the southern part of the site)
Uses immediately prior to redevelopment	Vacant car show room Vacant light industrial estate Derelict goods sheds Vacant land Kitchen showroom and warehouse (in use) Road haulage depot (in use)

Previous uses (Chettle and Chettle, 1997; BWB Consulting, 2003c; NLUD, 2006) (Development and Environmental Services Department, 2003) (Ordnance Survey, 1883; 1885; 1901a; 1901b; 1916; 1920; 1938; 1955a; 1955b; 1955c; 1955d; 1956; 1964a; 1964b; 1967; 1968a; 1968b; 1972a; 1972b; 1973; 1974; 1980; 1986; 1989; and 1990; Ottewell., 1996; BWB Consulting, 2003a; and 2003d)	**Radford Goods Yard:** Railway goods yard and railway station **Car show room area:** Car show room Residential Chettle's Yard: Light industrial estate Oil storage depot **Clearway Distribution Centre:** Warehousing Road haulage depot
Surrounding land uses (see Figure 54)	Student accommodation Mixed industrial and residential areas Residential areas The University of Nottingham's Jubilee Campus is located less than 500m to the south west of the site
Fit with context of larger area development	Part of the site is within the Neighbourhood Renewal strategy area for Nottingham No co-ordinated larger area redevelopment. It is complimentary to the expansion of the University of Nottingham's Jubilee Campus on brownfield sites nearby and the site has been identified as a suitable location for purpose built student accommodation
Planning context (Nottingham City Council, 2005a; 2005c)	Full planning application (02/00297/PFUL3) for student accommodation at car showroom submitted February 2002, no longer current Full planning application (02/01638/PFUL3) for residential and industrial development comprising 64 two bed apartments, student accommodation (507 bedspaces) and 9 industrial units (Phase 1) in August 2002. Conditional permission granted March 2005 Planning brief published by Nottingham City Council in February 2003 Outline planning permission (03/02432/POUT) for mixed use redevelopment comprising residential, student accommodation, industrial (B1 & B8) & retail (A1 & A3) uses, & associated works submitted in December 2003, decision pending Full planning application (05/01655/PFUL3) for additional 24 apartments as part of phase 1 granted conditional permission in November 2005 Full planning application (05/02506/PFUL3) for a further 8 additional apartments as part of phase 1 refused February 2006 Full application (05/02281/PFUL3) for relocation of Magnet showroom and warehouse granted conditional permission February 2006 Part of the site is allocated in the Nottingham Local Plan for employment generating uses and the whole site is included in the proposals map accompanying the Nottingham Local Plan
Transport links (see Figure 53)	500 metres from Nottingham's ring road Ca. 6.5 kilometres from Junction 26 of the M1 Motorway (5 kilometres as the crow flies) Nearest railway station is Nottingham 2.5 km south-east Nearest major airport is East Midlands 18 km south-west
Contamination (inc any	Contamination issues throughout the site, especially hydrocarbon

remediation carried out) (BWB Consulting, 2002)	contamination. Remediation work has been completed and verified at the Clearway Distribution Road Centre and Nottingham City Council has approved the details of ground contamination and gassing submitted to comply with the planning conditions. Remediation measures have included the installation of a gas venting trench, excavation and off-site disposal of sources of hydrocarbon, biopiling and monitoring of methane levels. In 1991 a containment cell was built in the north west of the site as part of the development of Midland Court to the north
Geology (BWB Consulting, 2003b; 2003d; and 2005a)	Made ground (0.8 to 4m) Superficial deposits: Clay and silt over sand and gravel (proved to a maximum depth of 6.5m) Solid geology: and Sherwood Sandstone over Coal Measures The Dunkirk fault, a major north-south fault with a downthrow to the east, crosses the site and throws the sandstone against the Coal Measures A branch fault that runs close to the line of the river Leen which throws the sandstone against the Coal Measures The former workings of the Radford colliery extend beneath the site in four seams at depths of between 60 and 270m
Hydrology (Tim North & Associates, 2003; Environment Agency, 2006)	The site is within the flood plain of the River Leen which flows through the southern part of the site and forms the eastern boundary in the northern part of the site The majority of the site is considered to be at significant risk from flooding with a chance of flooding each year of 1.3% (1 in 75 years) The River Leen adjacent to the site is considered to have fairly good biological and good chemical water quality but high levels of nitrates and phosphates. A branch of the River Leen that once flowed through the centre of the site now flows through sewers in the north of the site and through a culverted watercourse in the south
Hydrogeology (BWB Consulting, 2003b; 2003d; and 2005a)	The Sherwood Sandstone is a major aquifer The Coal Measures and drift deposits are minor aquifers. Groundwater is between 0.7m and 3.1m bgl and generally flows in a southerly direction to the River Trent but the shallow soils under the site are likely to drain into the River Leen The site is within Zone 3 (Total catchment) of the source protection catchment of the nearest groundwater abstraction point which is 700m to the south which draws from the Sherwood Sandstone to supply Queen's Medical Centre
Biodiversity (Tim North & Associates, 2003)	The flora and fauna of the site are considered to be of modest interest at most, with the banks of the River Leen being the feature of greatest conservation interest
Other Issues	The site has been subject to fly tipping (see Figure 55)

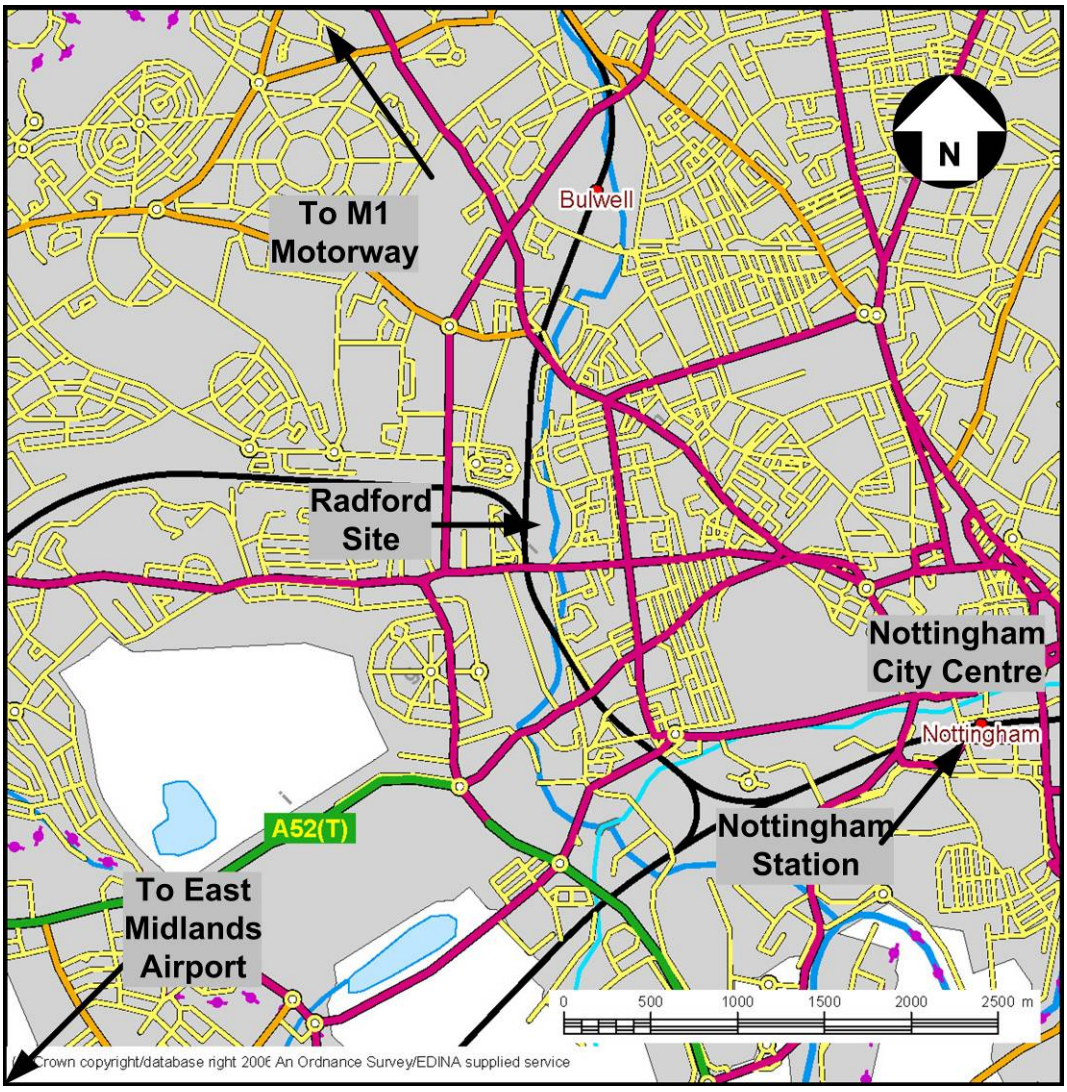


Figure 53: Location of the Radford site in Nottingham

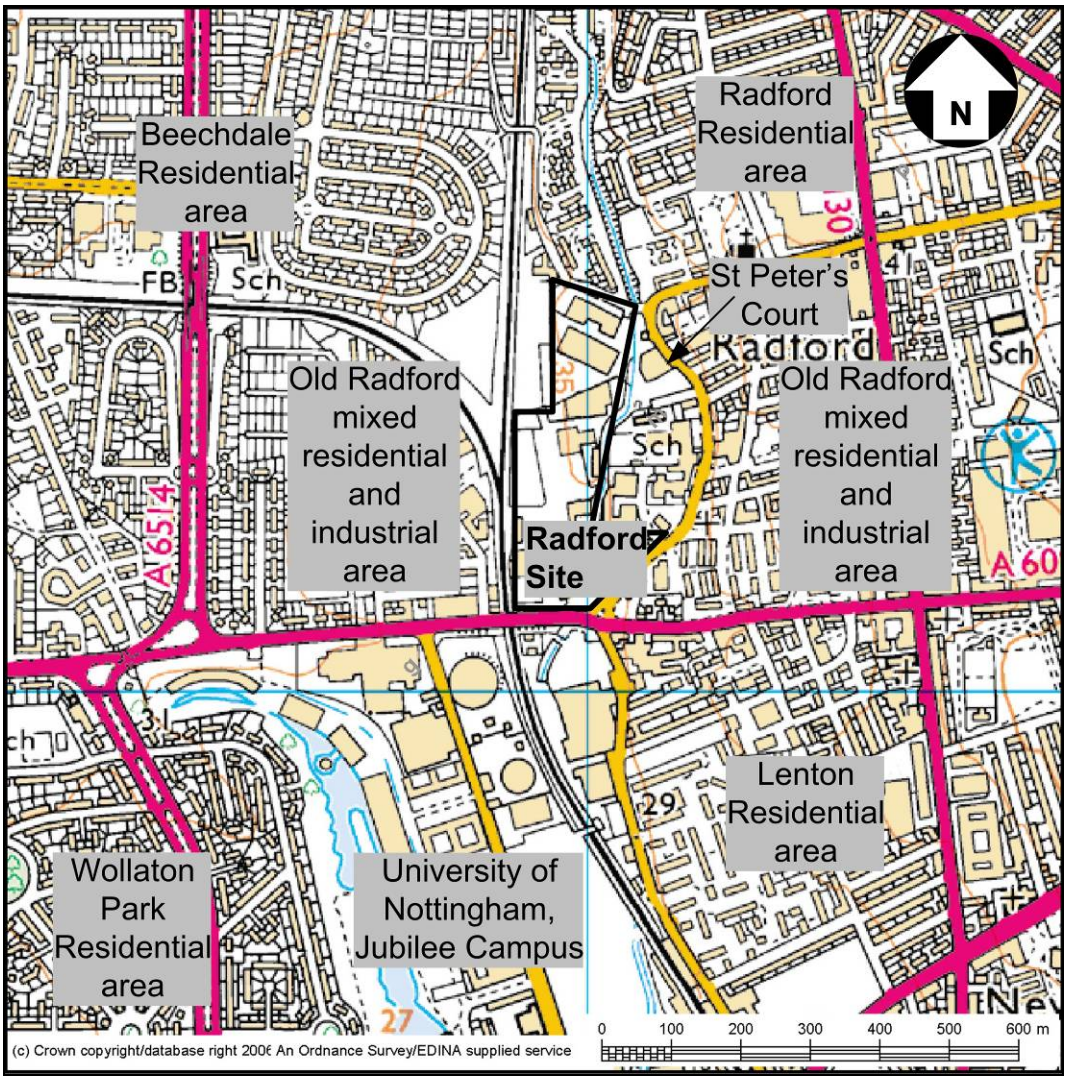


Figure 54: Land uses surrounding the Radford site

Figure 55: Fly tipping at the car showroom area of the site

8.2 Description of the Radford Area

Radford is an inner-city area of Nottingham that has large ethnic and student populations (ONS, 2001). It suffers from pockets of severe deprivation with some parts (including the area which contains the Radford site) among the 10% most deprived census super output areas in England (ODPM, 2004c) (Figure 56).

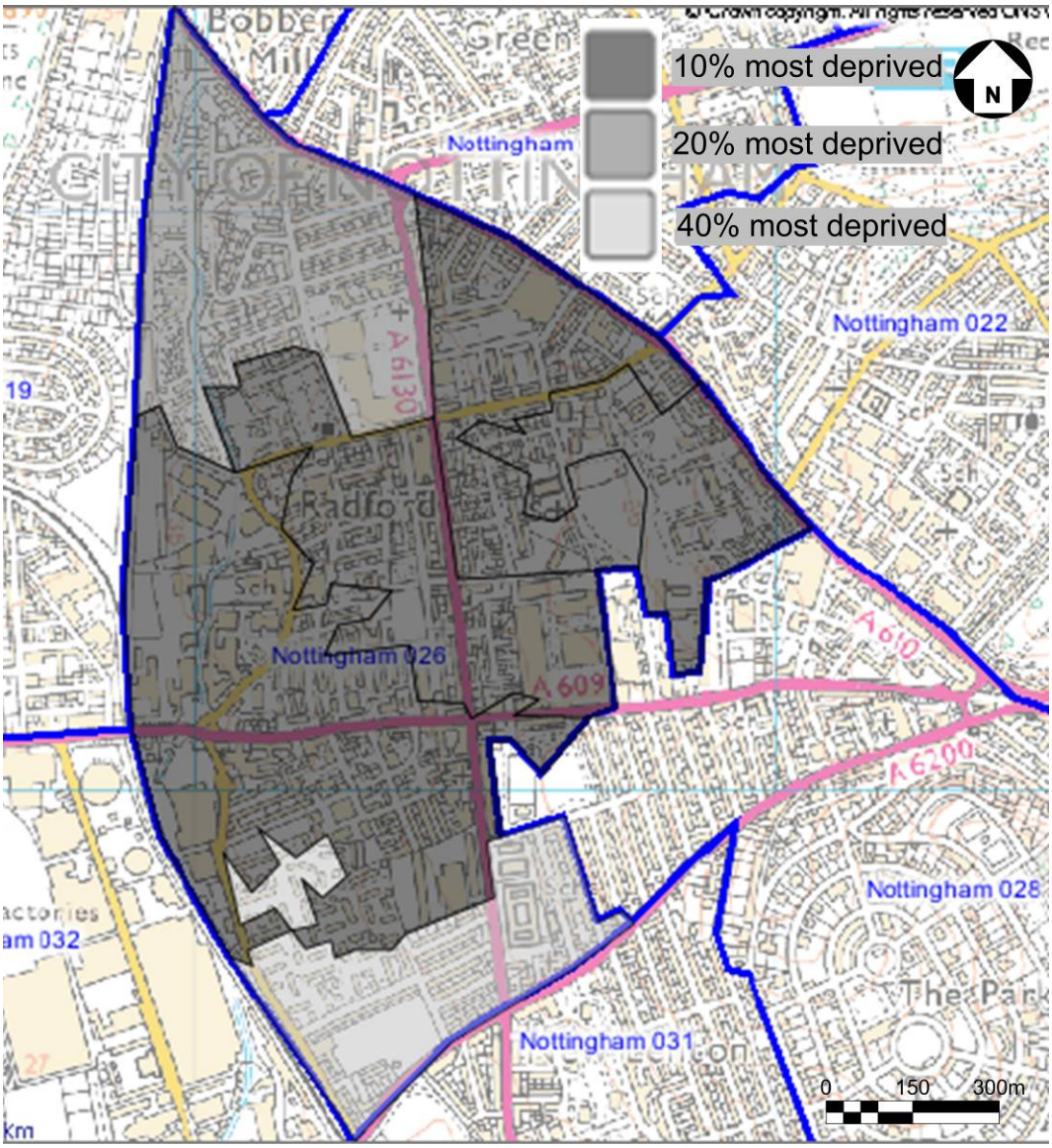


Figure 56: Deprivation in Radford

It has traditionally been associated with three major employers: Radford Colliery, Raleigh Bicycles and Players tobacco. Due to their close proximity there were many opportunities for employment, and it has even been said that unemployment was not a

word known in the local vocabulary (Weiss, 1996). However, Radford Colliery, Raleigh Bicycles and Players Tobacco have all ceased to operate in the area and unemployment was 4.6% in July 2006, above both the average for Nottingham (4.4%) and the UK (2.6%) (Nottingham City Council, 2006f).

8.3 Redevelopment of the Radford Site

The key stages of the redevelopment of the Radford site are shown in Figure 57. Developing a roadmap of the redevelopment process is a vital first step in carrying out Brownfield ReMIT/ReSPONSE for three of reasons. Firstly, it helps to develop an understanding of the system that is required for the later stages of BRR. Secondly, it provides a means summarise the key stages of the redevelopment process that can provide clarity to the complex process of redevelopment. Thirdly, the roadmap can guide the redevelopment process by identifying the steps that need to be carried out to deliver the redevelopment option identified using BRR.

8.3.1 Initiation of the Redevelopment of the Radford Site

In 1999, the NG7 Business Property Strategy Group (comprising Nottingham City Council, East Midlands Development Agency, Partnership Council[7] and Nottingham Regeneration Ltd) commissioned feasibility studies to examine how the underutilized potential of the site could be realized (Nottingham City Council, 2002). These studies concluded that comprehensive redevelopment following an agreed planning framework could contribute to the regeneration of the Radford area and a development brief was published (Nottingham City Council, 2002; Nottingham City Council, 2003b).

[7] A local community partnership that works in parts of Nottingham's inner-city areas

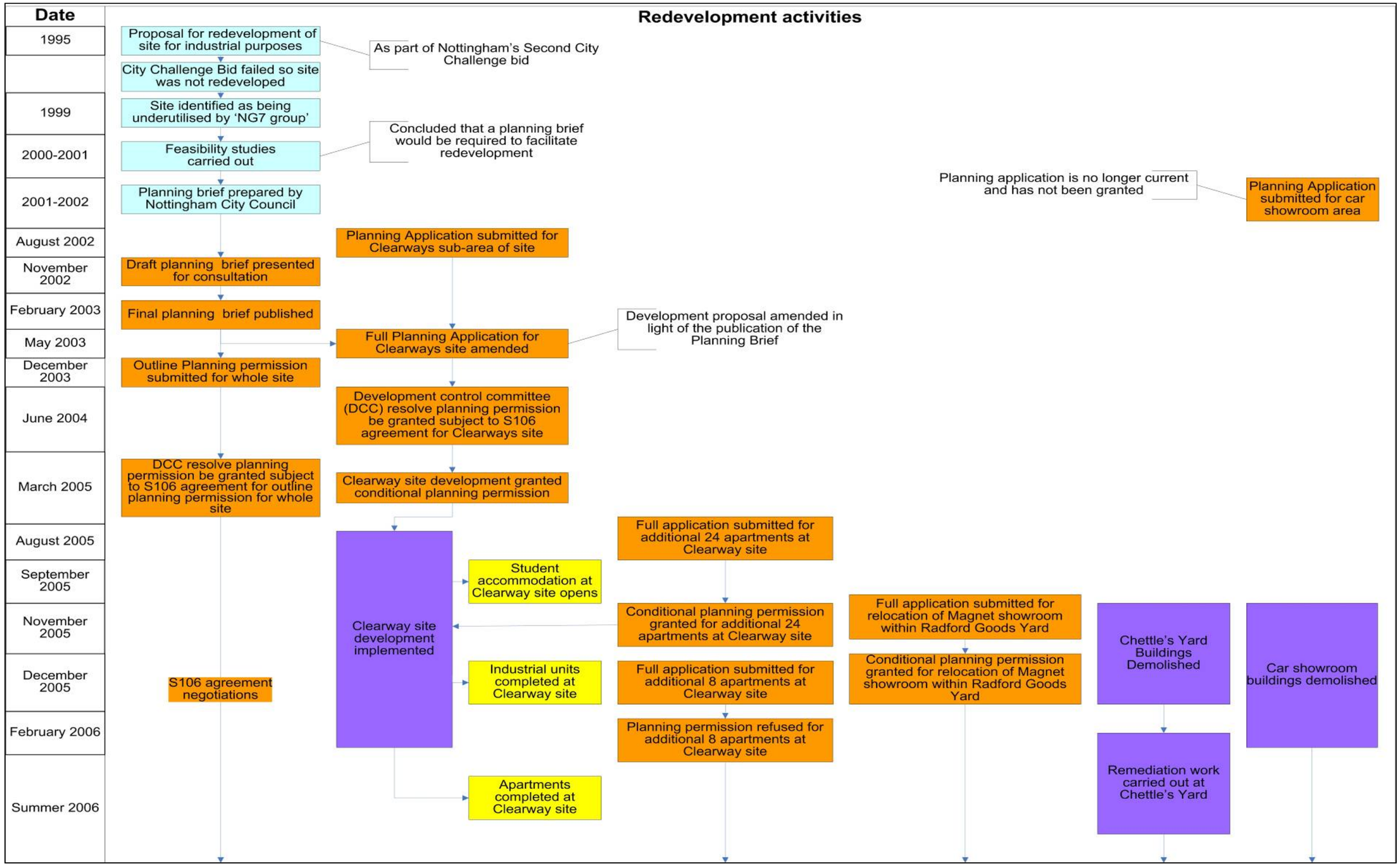


Figure 57: Roadmap of the redevelopment process at the Radford site (the colours match the stages of the redevelopment process, see Figure 19)

8.3.2 Characterisation, Planning and Design of the Redevelopment of the Radford Site

Site characterisation and investigation of the Radford Goods Yard, Chettle's yard and Clearways Distribution Centre areas of the site has focused on the contamination, geotechnical issues, ecology and flood risk (BWB Consulting, 2002; 2003b; 2003d; Davies Light Associates, 2003; Margeson, 2004; Rotherman, 2004; BWB Consulting, 2005b; BWB Consulting, 2005c; BWB Consulting, 2005a). In the Car Showroom area, there is little documentary evidence of site characterisation other than a contaminated land and geotechnical desk study (BWB Consulting, 2003c) but evidence from site visits suggests that further work may have been carried out. In addition, an environmental impact assessment of the outline planning proposal for the whole site has been carried out (Tim North & Associates, 2003).

A masterplan has been prepared for the site (Maynes Helmore, 2005) and outline planning permission has been applied for (Nottingham City Council planning application reference number 03/02432/POUT). This proposes that the eastern part of the site be redeveloped for student and key worker accommodation, the western part for employment generating uses and an area in the south for local convenience retail and a café or bar (Maynes Helmore, 2005). In March 2005, Nottingham City Council resolved to grant conditional planning permission subject to the completion of a section 106 agreement but over two years later this is still under negotiation (Nottingham City Council, 2005b). Despite this, full planning permission (Nottingham City Council planning application reference number 02/01638/PFUL3) has been granted for the first phase of redevelopment consisting of student accommodation, industrial units and private apartments in the Clearway Distribution area of the site

and permission has also been granted for the first part of the second phase which is the relocation of the Magnet showroom within Radford Goods Yard (George Wimpey East Midlands Ltd, 2005a; and 2005b; J E Chettle Ltd, 2005; Nottingham City Council, 2006d; 2006b; 2006c; and 2006e). The permissions include sections of a proposed spine road and riverside path through the site (Franklin Ellis, 2003). Prior to the Planning Brief being published (Nottingham City Council, 2003a), planning permission was sought for the development of student accommodation in the car showroom area of the site but this has since been withdrawn (Opal Property Group Ltd, 2002; Nottingham City Council, 2006a). However, in early 2006, notices were erected on the site to announce that a developer of student accommodation had acquired the site.

8.3.3 Implementation of the redevelopment of the Radford site

Demolition work took place at the Clearway area of the site prior to 2003 and in the car show room and Chettle's Yard area in 2005 and 2006. Demolition work has yet to take place at the Radford Goods Yard area. The remediation work in the Clearway area was completed in 2005 and consisted of the off-site disposal of hydrocarbon contaminated soil, the installation of a passive venting trench and ongoing gas monitoring (Margeson, 2004; BWB Consulting, 2005d). The remediation strategy of on-site biopiling hydrocarbon contaminated soil at the remainder of the site began in 2004 and is still on going (BWB Consulting, 2005a). Development work in the Clearway area of the site took place in 2005 and 2006 including construction, infrastructure provision and landscaping. Development and construction work has not yet begun at the car show room, Radford Goods Yard and Chettle's Yard Area.

8.3.4 Completion of the redevelopment of the Radford site

As of April 2007, only the first phase of redevelopment (see section 8.3.2) has been completed. The rest of the Radford site is still undergoing redevelopment.

8.4 Applying Brownfield REMIT/RESPONSE to the Radford Site

As Brownfield REMIT/RESPONSE was applied retrospectively at the Radford site to demonstrate that it is a suitable tool for analysing brownfield redevelopment and to determine the impact of policy on redevelopment the final three steps of the method were not applied (see Figure 50).

8.4.1 The Objectives of Redeveloping the Radford Site

Redevelopment Objectives the Radford Site

Nottingham City Council's objectives for the Radford site are (Nottingham City Council, 2003a):

That it be redeveloped to allow its optimal use (although explanation of what constitutes the optimal use is not given);

That the site should be comprehensively redeveloped within a single design framework rather than in a piecemeal fashion;

That the redevelopment addresses the problems of contamination and unsightly buildings on site;

That environmental enhancements are carried out on site, such as providing public access to the River Leen, and;

That developers contribute to any on and off site infrastructure improvements deemed necessary by the council.

Regeneration Objectives

The Council's regeneration objectives for redeveloping the Radford site are:

That part of the site (1.18 hectares) be developed for employment generating uses creating at least as many jobs as there were prior to redevelopment (although no mention is made of how many jobs this constitutes) (Nottingham City Council, 2003a; Nottingham City Council, 2005c);

That the local housing stock is increased (no specific number of new houses is specified) (Nottingham City Council, 2003a), and;

That local food shopping provision and choice are improved (Nottingham City Council, 2003a).

Constraints

The constraints within which these objectives must be met can be divided into policy derived constraints and constraints related to the site (Table 19 and Table 20).

Table 19: Policy constraints at the Radford site (Nottingham City Council, 2001; and 2005c)

Allocation of the site for employment creating uses with enabling uses (residential and retail) (Figure 58)
The need to provide on- and off-site infrastructure including infrastructure to connect the site with the surrounding urban area
The need to provide a pedestrian and cycle path along the River Leen
Density limits: 30 to 50 dwellings per hectare for family housing, higher densities permitted for student accommodation
Requirement to provide 20% affordable housing on site or through contribution to the council
The need to meet, or overturn, the requirements of planning policy in order to be granted planning permission

Table 20: Site constraints at the Radford site (Nottingham City Council, 2001; and 2005c)

Location within flood plain
Land contamination and geotechnical issues
Lack of access to parts of the site
Fragmented ownership of the site
Existing buildings being functionally obsolete
Economic viability of industrial land uses within the area

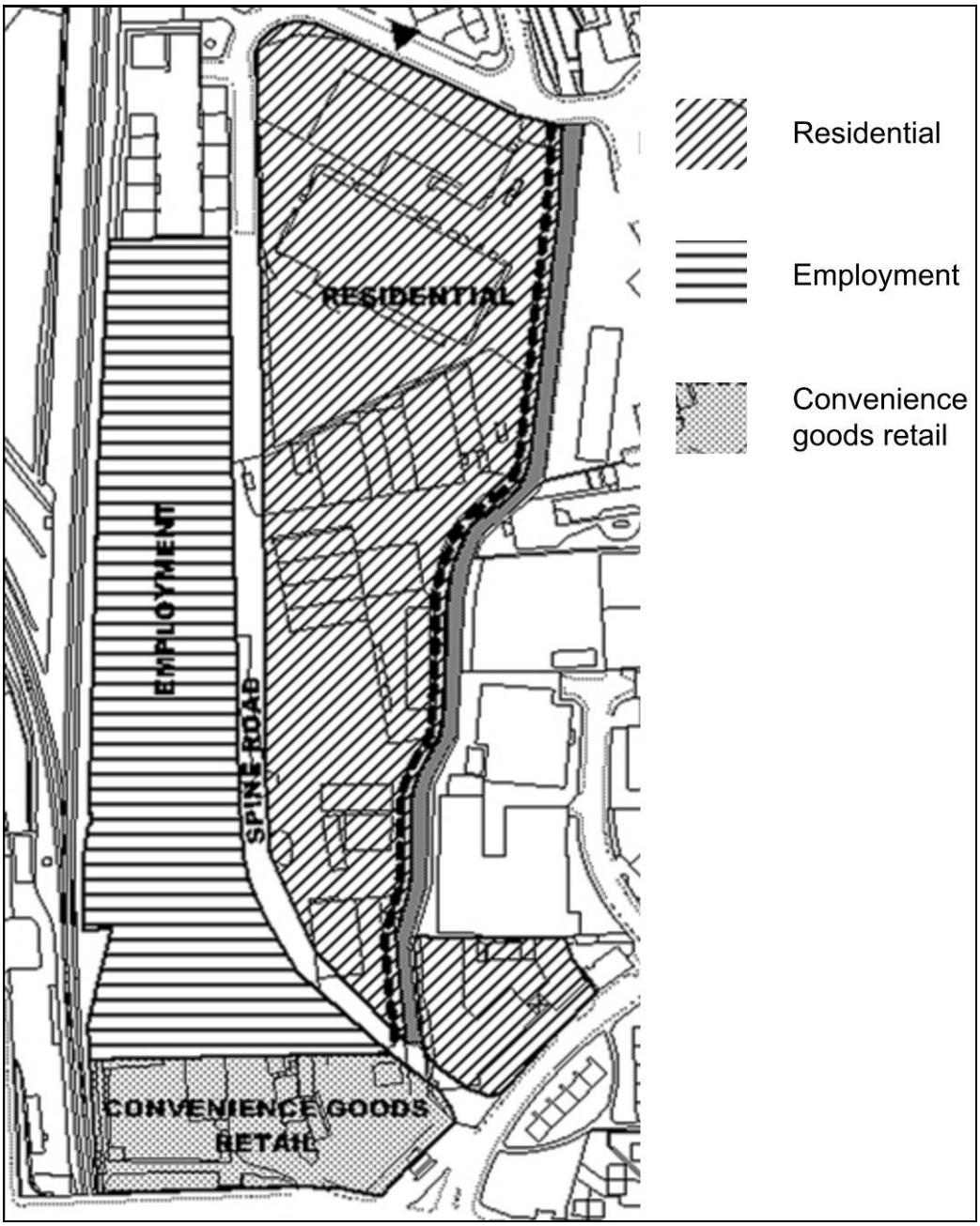


Figure 58: Detailed land use allocation outlined in the Planning Brief for the Radford site (Nottingham City Council, 2003a)

Changes since the Objectives Were Set

Since the objectives were set, the Radford site has been identified as being suitable for student accommodation due its proximity to the Jubilee Campus of the University of Nottingham (Nottingham City Council, 2005a). In addition a new objective has been introduced which specifies that the development of student accommodation should maintain or create a balanced community, which is defined, rather crudely, as one

where the proportion of student households is less than 25 per cent (Nottingham City Council, 2005a). Therefore, there is one additional regeneration objective, that the site provide purpose built student accommodation, and one additional policy constraint, that the development should not cause the community to have more than 25 percent student households.

8.4.2 Identifying the Main Components of the Urban System at the Radford Site

The site, the surrounding area and the redevelopment project are the main components of brownfield redevelopment (see section 7.4.2). At this stage it is important to remember that the aim of this chapter is to:

Investigate how Brownfield REMIT/RESPONSE can be applied to analyse brownfield redevelopment, and;

Determine the impact that planning and environmental policy had on the redevelopment of the Radford site.

Therefore, it is necessary to include policy as a component in the urban system (Figure 59).

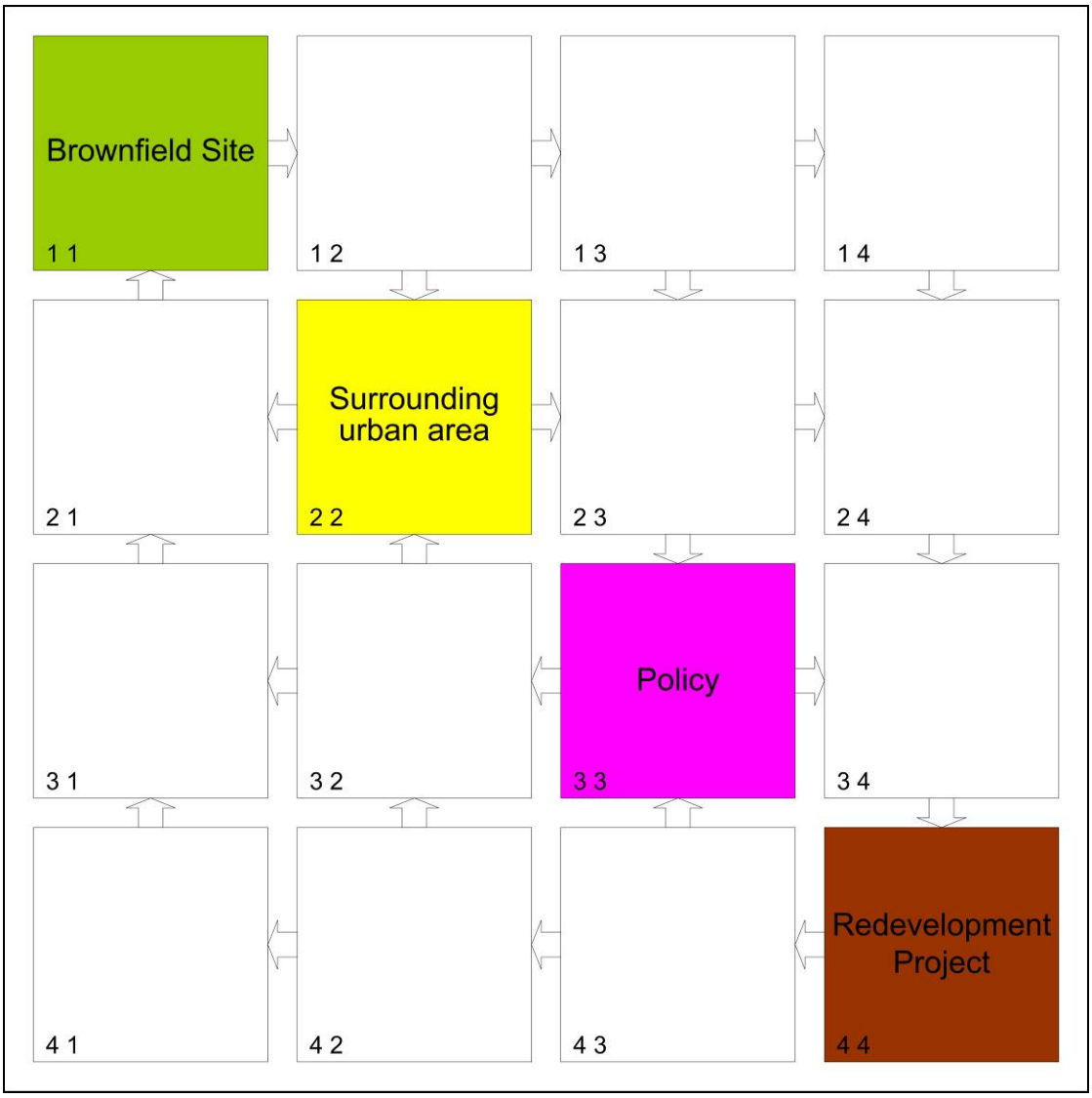


Figure 59: Interaction matrix showing the key components of the brownfield redevelopment system at the Radford site

Based on an initial analysis of the urban system and the redevelopment objectives, three sub-components were chosen to represent each of the four main components giving the following twelve leading components to represent the system at Radford (the colour coding in Figure 60 matches that of Figure 59 so can be used to identify which of the four main components each of the subcomponents is associated with):

1. General site characteristics (GC): which include the size of the site, its location and surroundings, its shape and other general characteristics;

2. Natural environment of the site: (NE): which includes the geology, topography, geotechnics, hydrology, hydrogeology, biodiversity and any other natural aspects of the site relevant to the project;
3. Land quality (LQ): defined as the scale, nature and extent of contamination on the site;
4. Social mix (SM): the balance between students and permanent residents;
5. Housing stock (HS): the number and type of dwellings;
6. Jobs provided (JP): the number of jobs provided;
7. Local policy (LP): which includes any site specific policies, any policies relevant to the area or neighbourhood and any Nottingham City Council policies such as the Local Plan;
8. Development control (DC): which is considered relevant as it is the interface between planning policy and the redevelopment process (see section 4.2.3);
9. Other policy (OP): which includes all other policies that are relevant to the redevelopment project such as national and regional planning policy and the policy of other bodies like the Environment Agency;
10. New land use (LU): the type and layout of the land uses introduced by the redevelopment of the site;
11. Site characterisation (SC): the characterisation, investigation and assessment carried out as part of the redevelopment process, and;
12. Work to implement the redevelopment (WI): the work carried out during the implementation stage of the redevelopment.

Due to a lack of information about the potential for shopping provision on the site and the potential impact of this on the surrounding area, the objective to increase local shopping provision has not been considered in this application of Brownfield REMIT/RESPONSE (for applications that do consider retail provision within redevelopment see chapter 9).

There is no detailed method for selecting the leading components to represent the system and this step relies heavily of the judgment of the person or people carrying out the modelling. However, stakeholder consultation could be carried out at this stage to ensure that the different stakeholders involved in the redevelopment process agree that they are suitable (this has not been carried out in this research).

These twelve leading diagonals enable the identification of 132 off-diagonal terms representing the associated brownfield redevelopment mechanisms, the atlas of mechanisms **(**Figure 60**).** It should be noted that some of the off-diagonal terms are blank because it has not been possible to identify the associated interaction mechanism.

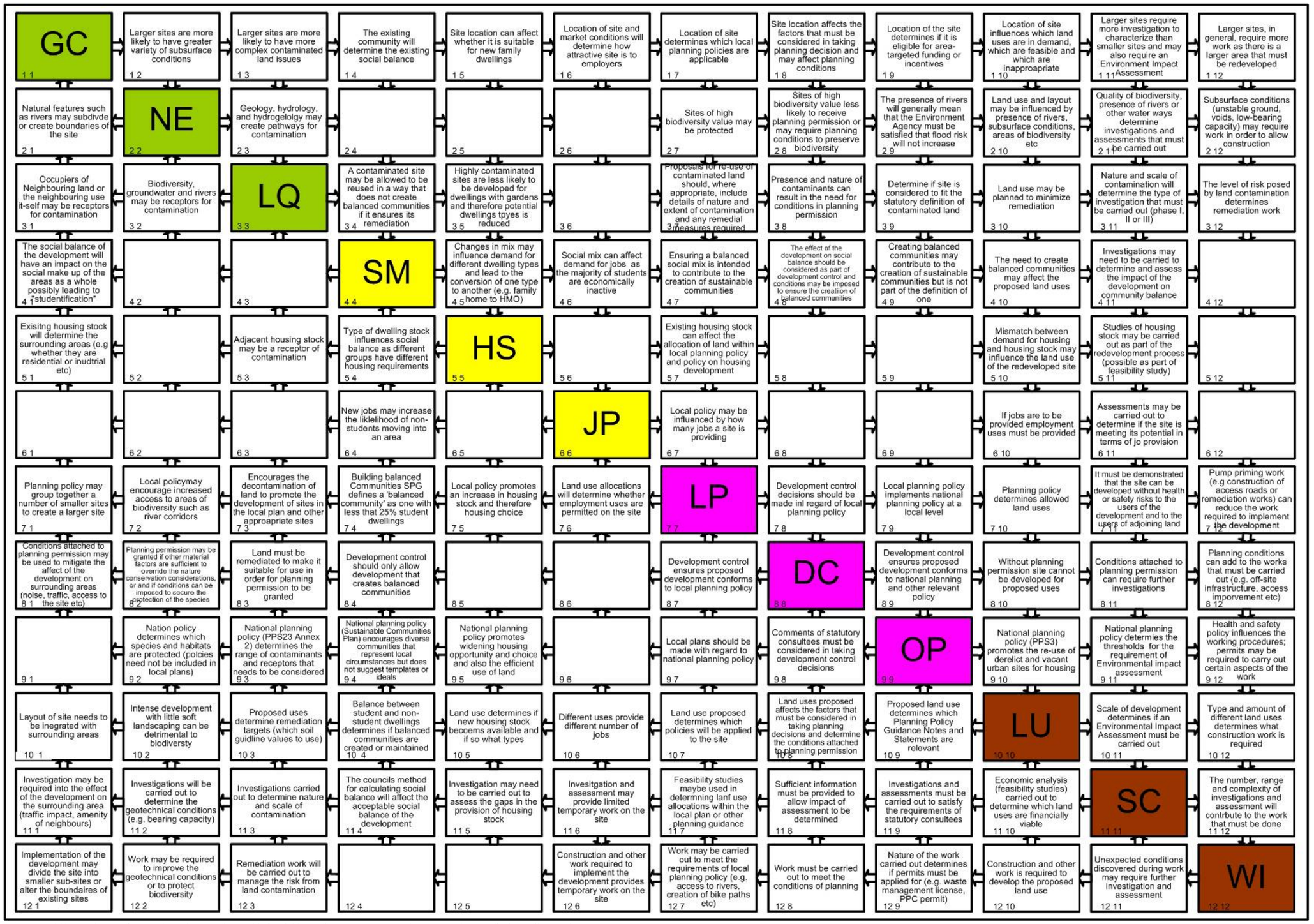


Figure 60: Atlas of mechanisms (see CD-ROM for an expanded version of this figure)

8.4.3 The Generic Interaction Matrix

The generic interaction matrix (Figure 61) is a binary-coded representation of the atlas of mechanism (1 = mechanism is present, 0 = mechanism is not). It indicates the system is highly interactive with 107 out of 132 mechanisms present. The cause and effect diagram (C,E diagram) of the binary coded generic matrix (Figure 62) shows a cluster of the components in the top right of the diagram, which indicates that they are highly interactive, and a mean cause and effect ($\overline{X}$) of 8.9. It also shows that three of the components (general site characteristics, land quality and work to implement the redevelopment) are dominant components (i.e. they have more effect on the system that it has on them), three (jobs provided, social mix and housing stock) are subordinate (i.e. they have less effect on the system that the system has on them and that six (new land use, site characterisation, natural environment of the site, local policy, development control and other policy) are balanced (i.e. they have the same amount of effect on the system as the system has on them). The plot shows that new land use, site characterisation and local policy are the most interactive components, jobs provided the least interactive and the most subordinate and general site characteristics the most dominant.

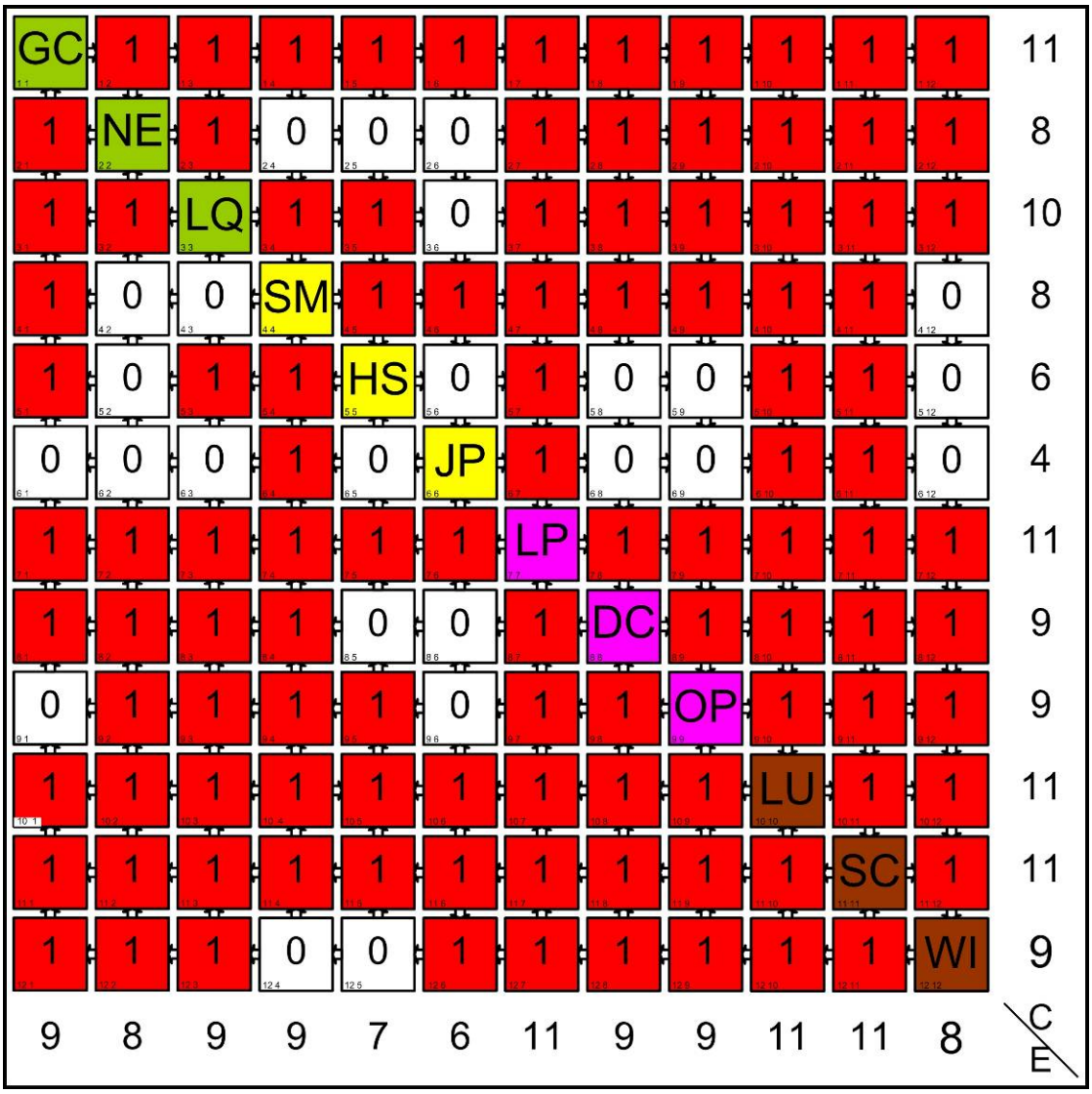


Figure 61: The generic interaction matrix

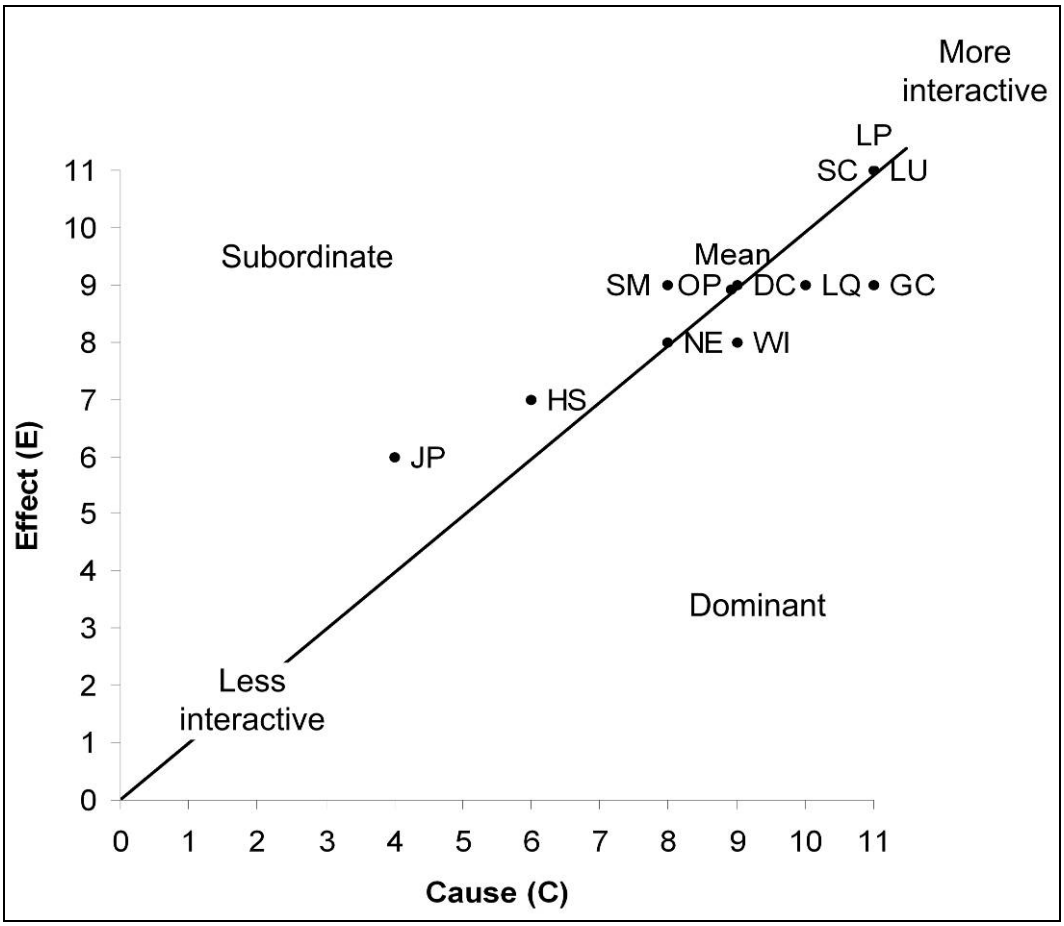


Figure 62: The C,E diagram for the generic matrix

8.4.4 The Site Specific Matrix for the Radford Site

The site specific binary matrix (Figure 63) identifies which of the mechanisms identified in the atlas of mechanisms are active at the Radford site and indicates that the system at Radford is less interactive than the generic system with only 72 out of 132 mechanisms active but it can be clearly seen the majority of the mechanisms that are not present involve the surrounding urban area. This indicates that the redevelopment process may be somewhat disconnected from its surroundings. This is significant as the redevelopment of brownfield sites for student accommodation is intended to contribute to the regeneration of the surrounding urban area (Nottingham City Council, 2005a).

The C,E diagram of the site specific binary coded matrix (Figure 64) shows a much greater distribution of interactivity (distance along the line of equal cause and effect) and dominance (distance from the line of equal cause and effect) than the generic matrix and also a lower mean cause and effect of 6.0. It also shows that six of the components are dominant (general site characteristics, natural environment of the site, land quality, social mix, housing stock and site characterisation and investigation), five are subordinate (jobs provided, local policy, development control, the new land use of the site and work to implement the development) and only one is balanced (other policy). The plot shows that new land use is the most interactive component, jobs provided the least interactive, local policy the most subordinate and general site conditions the most dominant.

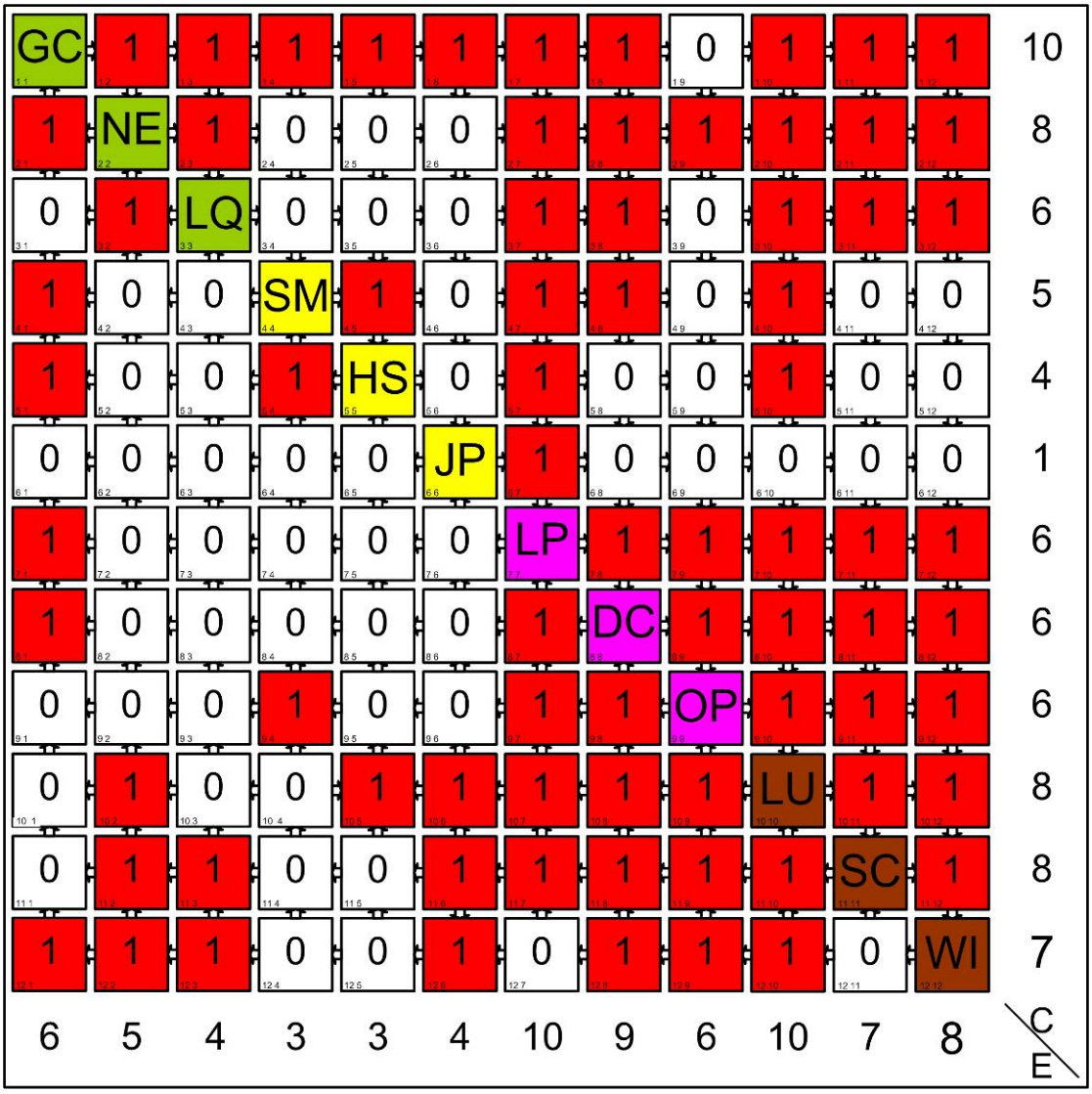


Figure 63: Binary Coded Radford Site Specific Matrix

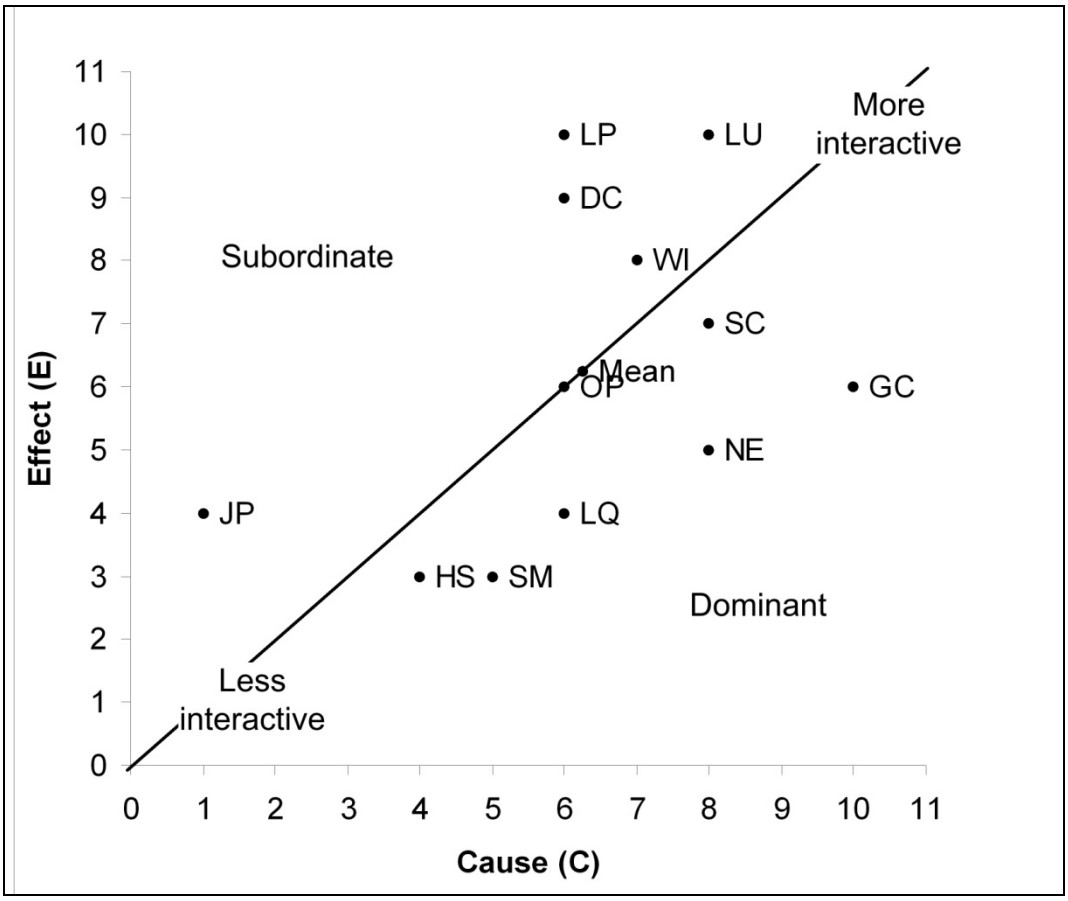


Figure 64: The C, E diagram for the binary coded Radford Site Specific Matrix

To further explore the nature of the urban system, the interactions were coded using the expert semi-quantitative (ESQ) method (Figure 65) (see section 7.3.5). This suggests that the system was less interactive than identified in the previous matrices as it had a total score of 186 out of a potential 576 (equivalent to 46.5 out of 144) and an average cause and effect of 15.5 out of 44 (equivalent to 3.9 out of 12).

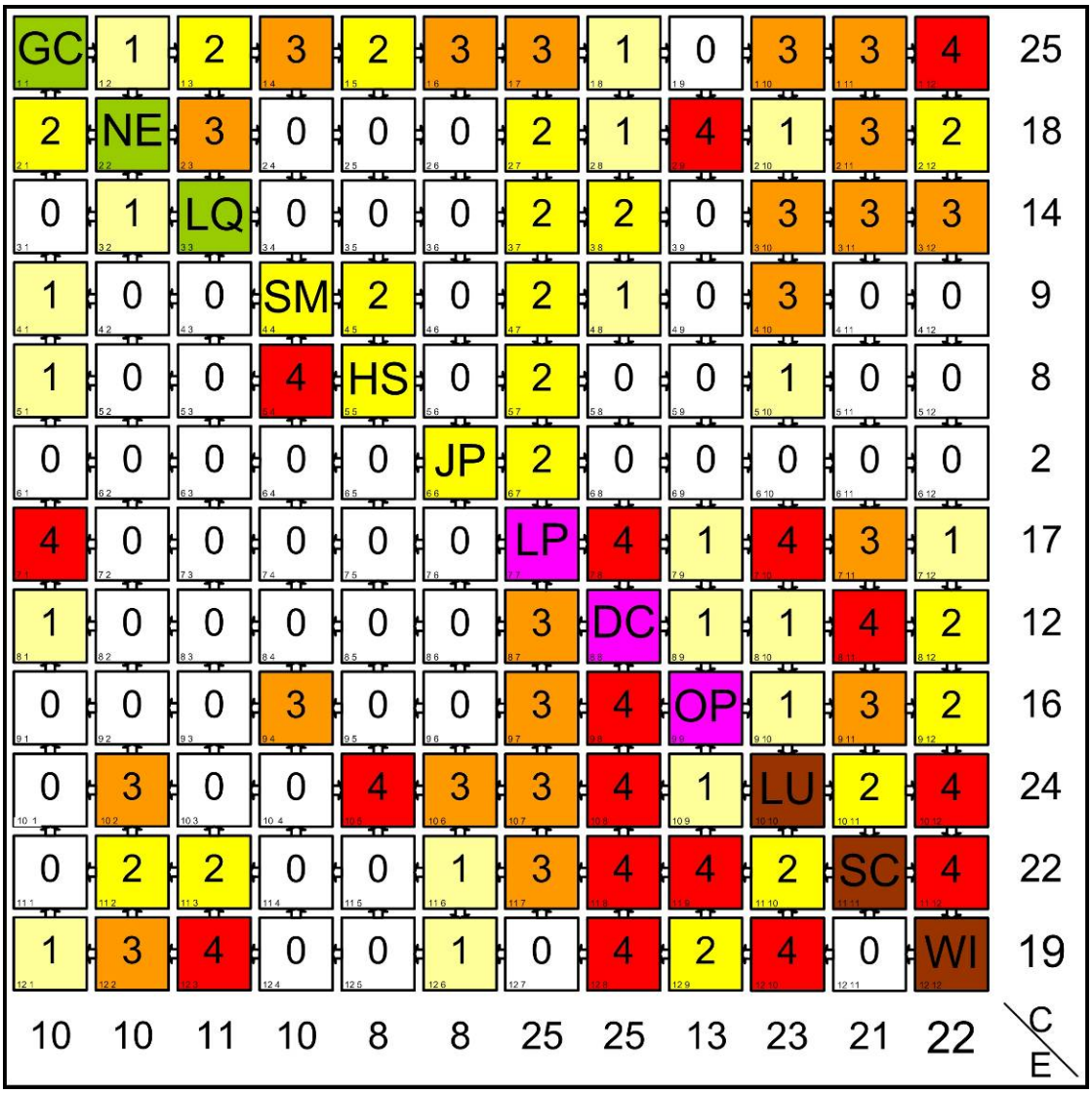


Figure 65: Expert-semi quantitative Coded Radford Site Specific Matrix (see appendix A for justifications of the matrix coding)

The C,E diagram of the ESQ-matrix (Figure 66) reflects this as it shows the cluster of components closer to the origin than in either of the two previous plots. This is as expected because the expert semi-quantitative method quantifies the strength of each interaction and therefore unless every interaction was considered to be 'critical' the ESQ coded matrix will always be less interactive than the binary coded matrix. The plot shows that six components are dominant (new land use, site characterisation and investigation, general site characteristics, natural environment of the site, land quality and other policy), five are subordinate (local policy, development control, work to implement the development, social mix and jobs provided) and only one (housing

stock) is balanced. The plot shows that new land use is the most interactive component, jobs provided the least interactive, development control the most subordinate and general site conditions the most dominant.

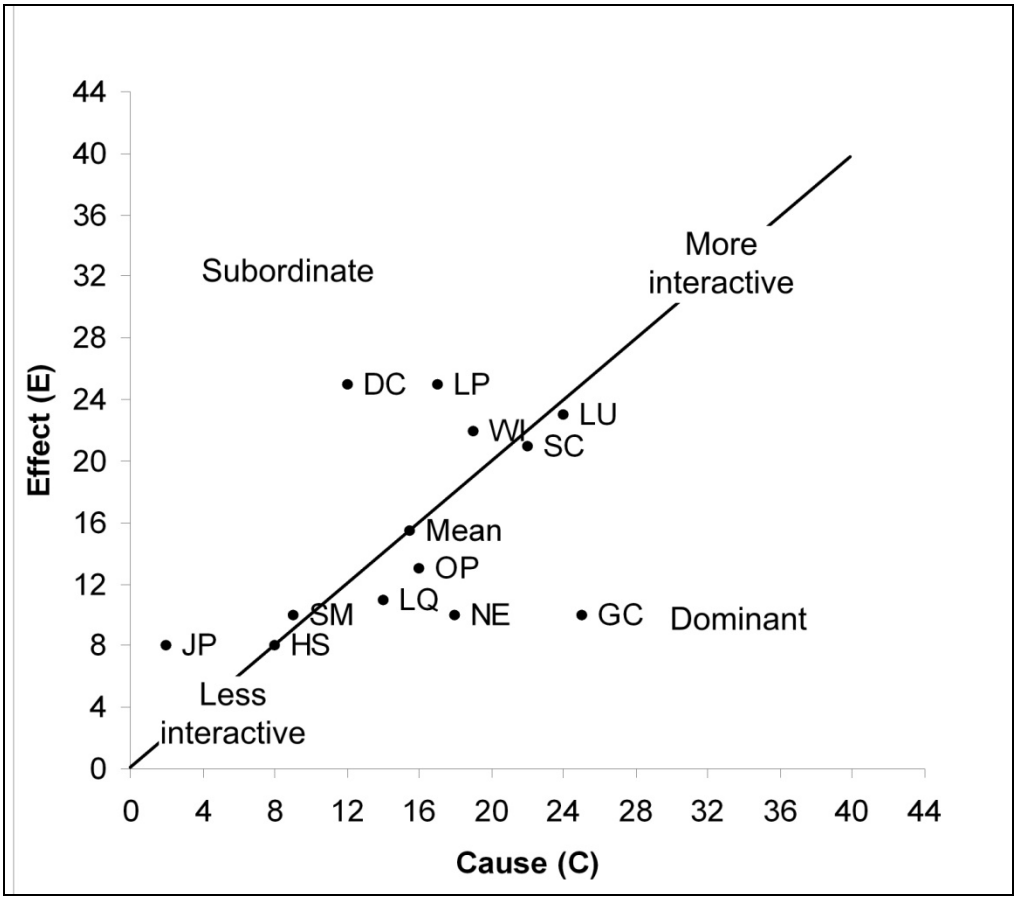


Figure 66: The C,E diagram for the ESQ coded Radford site specific matrix

Further analysis of the 'critical' interactions within the system identified in the ESQ-coded matrix (Figure 67) identifies that development control is the most critically dependant as five other components have a critical influence over it. Figure 67 is a reinterpretation of Figure 65 that includes only the 'critical' interactions (those with a score 4 which can be identified in Figure 65 as being coloured red). Each of the circles in the figure represents a component of the system and the arrows indicate a 'critical' relationship, with the direction of the arrow indicating which component has a critical influence over the other component. For example the arrow connecting housing stock

(HS) to social mix (SM) indicates that housing stock has a 'critical' influence over social mix.

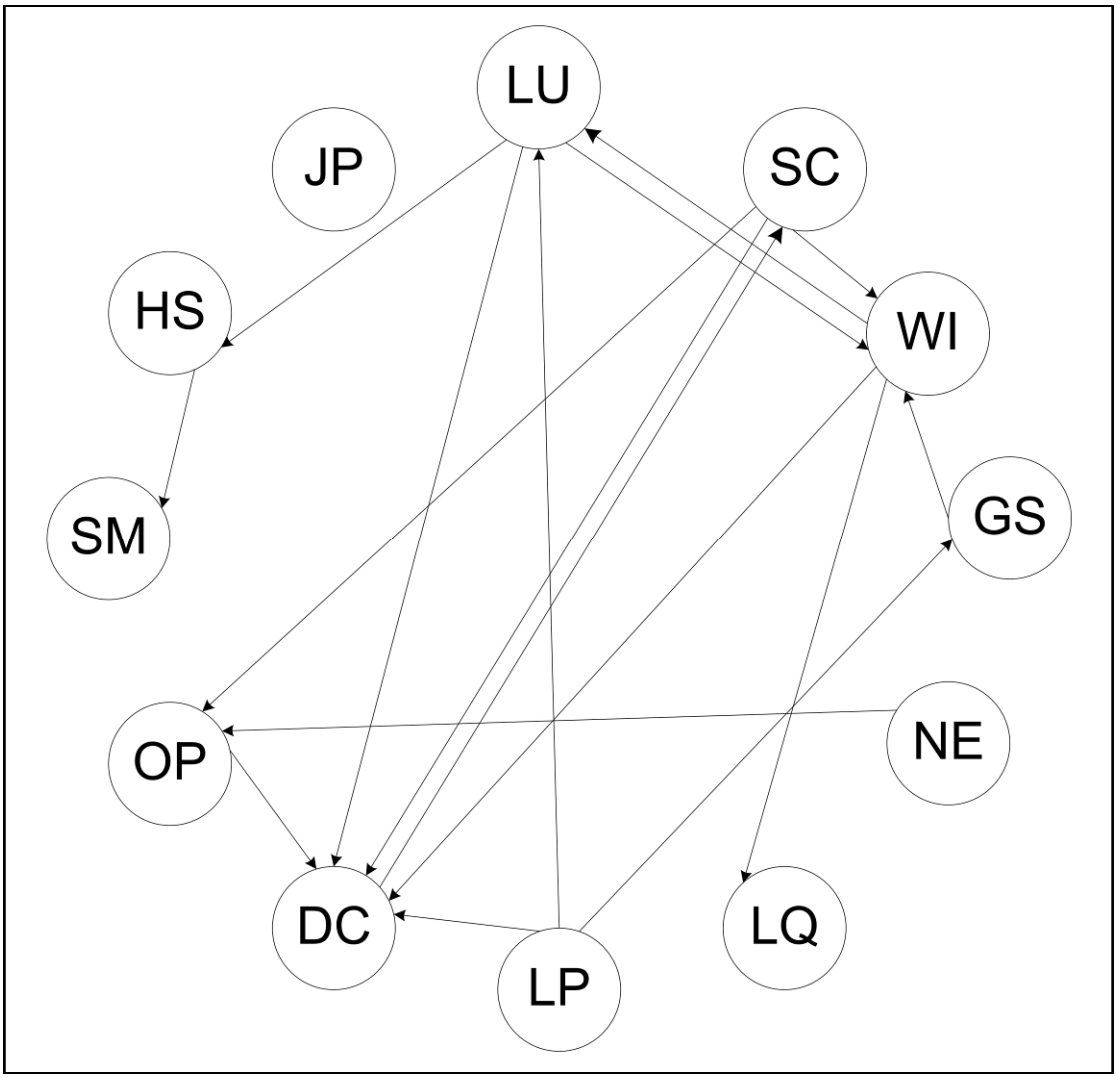


Figure 67: Directionality of 'Critical' interactions at the Radford site

Land use, work to implement the development, local policy and site characterisation are the most influential as each has three critical influences over other components. In planning terms this means that any changes to the system that influence these components are likely to have a significant impact elsewhere in the system. For example, if a change was planned to local policy it can be instantly seen that this is likely to cause changes to development control, the proposed land use of the site and the general site characteristics as these are all critically dependent on local policy. Work to implement the development and development control are the most interactive

with six critical relationships each and jobs provided the least interactive with none. Natural environment of the site, local policy and jobs provided are the only components not critically influenced by any other components.

8.5 The Impact of Policy on the Redevelopment of the Radford Site

The application of Brownfield REMIT/RESPONSE to the Radford site identified five mechanisms where one of the three policy components (local policy, development control and other policy) had a critical influence over another component of the urban system (although it should be noted that two of these were between the different policy components). Despite both local policy and development control being subordinate in the ESQ-coded site-specific matrix (Figure 66), each have critical impacts on other components (Figure 67): the former over development control, land use and general site characteristics and the latter over site characterisation. Other policy was dominant overall but only had one critical impact, on development control. This section assesses the impact of these five critical influences in further detail.

8.5.1 The 'Creation' of the Radford Site and Initiation of the redevelopment of the site

Brownfield REMIT/RESPONSE identified that local policy had a critical influence on general site characteristics. This was because the Radford site was created by policy. The site is made up of four separate zones that have not historically formed a single site and the earliest evidence of them being considered as such is as part of Nottingham's second city challenge bid (Nottingham City Council, 1995). Subsequently the site has been considered to be a single brownfield site in a number

of other policies (Nottingham City Council, 2003a; 2004d; and, 2005c). Given this it is not surprising that fragmented ownerships have been a barrier to redevelopment.

In addition to the involvement of the NG7 Business property group (see section 7.2.1) there have been a number of other policy related stimuli to the initiation of the redevelopment process. Firstly, the expansion of the University of Nottingham as part of a UK wide expansion of universities that has been driven by Government policy, has resulted in an increase in the number of students requiring accommodation (Charlton and Andras, 2002; Nottingham City Council, 2004d). The response of Nottingham City Council to this has been to encourage the development of purpose built student accommodation in locations that would assist regeneration (Nottingham City Council, 2005a). This has created a climate conducive to the redevelopment of brownfield sites in the western part of Nottingham for student accommodation.

8.5.2 The Impact of Local Planning Policies on the Redevelopment of the Radford Site

Brownfield REMIT/RESPONSE identified that local policy had a critical influence on development control and on the land use chosen because local policy determines which land uses are appropriate and sets the framework within which development decisions will be made. The Nottingham Local Plan contains 40 policies relevant to the development proposals at the Radford site (Table 21).

Table 21: Nottingham Local Plan Policies affecting the Radford site (Nottingham City Council, 2005c)

Policy type	Applicable to Radford site given development proposals
Strategy	3
Housing	4
Economy and employment	1
Regeneration and mixed use	0
Shopping and town centres	2
Recreation and leisure	3
Community, health and education	0
Built environment	12
Natural environment	8
Transport	7
All	40

However, only the allocation of part of the site for employment uses (policy E2.14 in the local plan) is specifically related to the Radford site. Suggestions that the site be reallocated as a mixed use site were rejected on the grounds that it would reduce the ability of the city council to ensure that employment uses occur, which explains why no regeneration or mixed use policies are relevant to the site despite the council promoting the redevelopment of the site for a mixture of uses to deliver regeneration (Stiles, 2004). Of the remaining policies, the majority are related to the criterion against which development proposals will be assessed. In general, rather than providing specific targets the policies are related to what is appropriate in the given setting: for example planning permission will be granted for residential development where the mix of type and size of dwelling is appropriate given the surrounding area (Policy H3 - Nottingham City Council, 2005c). However, some have influenced the land use of the site including the policy to secure public access to the River Leen (Policy R4) which in combination with the requirement for a cycle and footpath along the River Leen in the planning brief (see section 8.5.3) resulted in the amendment of

the development proposals at the Clearway Distribution area. Overall, the impact of the local plan on the redevelopment of the Radford site has been to encourage its redevelopment to provide employment generating uses and it also provides the framework by which planning applications will be assessed.

The proposals map that accompanies the Nottingham Local Plan (Nottingham City Council, 2005c) includes five policies and allocations that affect the site and nineteen that affect the immediate surroundings (Figure 68 and Table 22).

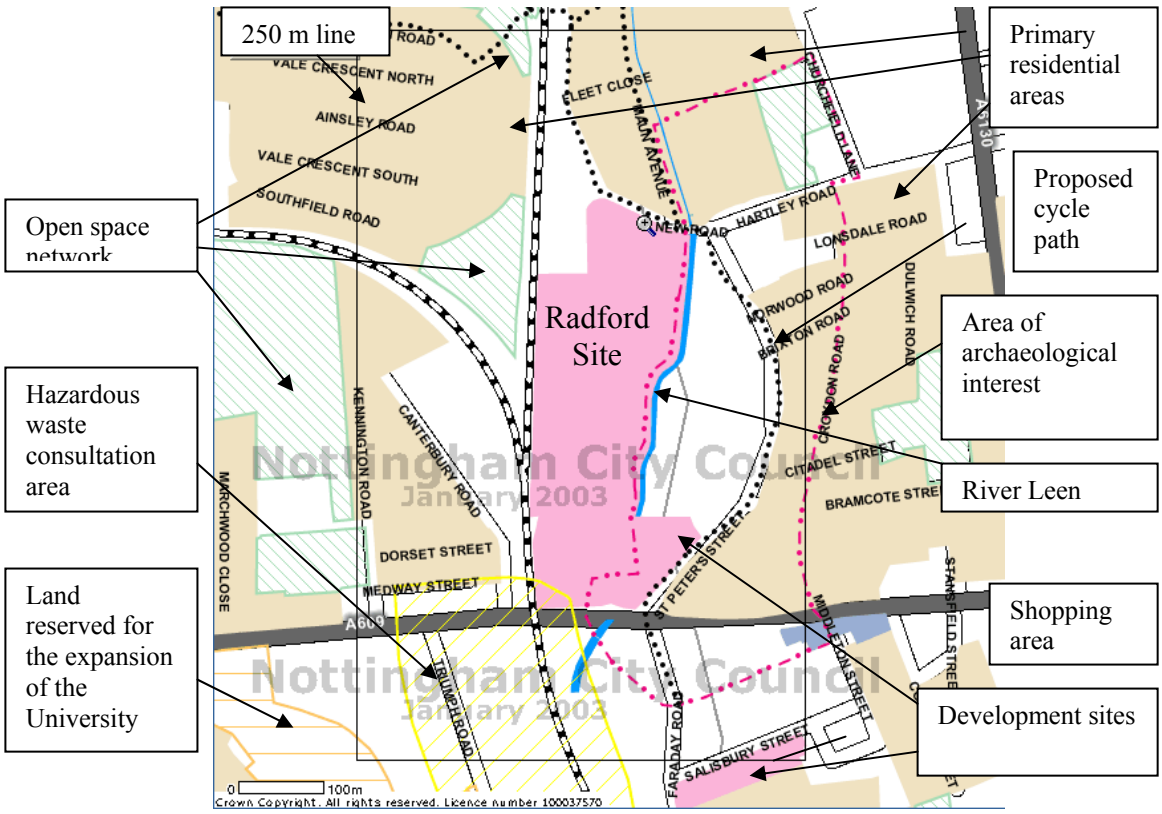


Figure 68: Planning proposals map at the Radford site and immediate surroundings

Table 22: Land use policies and allocations at the Radford site

Policy type	On site	Within 250m of the site
Housing	0	4
Economy and employment	1 (E2.14)	1
Regeneration and mixed use	0	0
Shopping and town centres	0	7
Recreation and leisure	1 (R4)	5
Community, health and education	0	1
Built environment	1 (BE16)	0
Natural environment	2 (NE10, NE11)	0
Transport	0	1

Of those that are present on site policy R4 and E2.14 have already been described in this section. Of the other policies present at the site two have had little or no impact on the redevelopment: an area of archaeological interest that requires an archaeological desk study or field evaluation to be carried out as part of any planning applications (Policy BE16) and a hazardous installation consultation area related to the Triumph Road gas depot (NE10). This is due, in part, to these policies only being applicable to small areas of the site which have not yet been part of any detailed planning applications. The final policy relevant to the site relates to the water quality and flood protection (NE11) and is relevant due to the location of the site adjacent to the River Leen. The impact of this policy and of other policies related to flood risk is discussed below (section 8.5.4). Of the policies that affect the immediate surroundings only the re-routing of a proposed bicycle path through the site has had an impact on redevelopment (Figure 68).

Two changes to planning policy have affected the viability of the redevelopment of the site. The first was the re-allocation of the site from "employment generating uses" to "employment generating uses with enabling uses" (Nottingham City Council, 2005c). This allows developers to off-set any losses made whilst developing the employment generating uses with the profits from developing residential uses elsewhere on the site. The second was the expansion of the allocated site on the proposals map to include the whole of the Radford site thus ensuring that the development of the employment uses was intrinsically linked with the redevelopment of the whole site. These changes resulted in a land use allocation that was commercially viable, even though it was probably not the most profitable option, and ensured that the council's objective of providing employment generating uses would be delivered through the private-sector redevelopment of the site.

8.5.3 Impact of the Development Brief on the Redevelopment of the Radford Site

The development brief was another local policy that had a critical impact on the land use of the site (Nottingham City Council, 2003a). The purpose of a development brief is to provide site-specific planning guidance to ensure that the objectives of the city council are achieved and that the general public benefits from redevelopment (Nottingham City Council, 2005c). For the Radford site the brief provides information for developers regarding the type of development that is considered appropriate, the type of site investigations that may be required and other information relevant to the development process (Nottingham City Council, 2003a). The impact of the brief on the redevelopment has been most evident in the Clearway zone of the site, largely as it is the only part of the site with detailed planning permission. The first impact was that a decision on planning permission for redevelopment was delayed until after publication of the development brief, presumably so as not to prejudice or constrain the contents or delivery of the brief. Once the brief had been published the proposed student and residential accommodation was amended, the proposed path along the River Leen added and slight alterations made to the access road to the industrial units which forms the first part of the spine road through the site (Franklin Ellis, 2003). These amendments ensured that the proposed development met the requirements set out within the brief and that the redevelopment contributed to the coherent development of the whole Radford site. However, it is not possible to assess how the brief has impacted the rest of the development as it has not taken place yet.

8.5.4 The Environment Agency, Flood Risk and the Redevelopment of the Radford Site

Brownfield REMIT/RESPONSE identified that other policy had a critical influence over development control and this was due to the Environment Agency's objection to the proposed development. Nottingham City Council's policy is that planning permission will not be granted for development where it would increase the risk of flooding or be at risk from flooding (Nottingham City Council, 2005c). Based on a flood risk assessment carried out as part of the outline planning application for the whole site the Environment Agency objected to the development as it felt it would increase the risk of flooding elsewhere (Nottingham City Council, 2004c). However, it was proposed that the objection could be overcome by the submission of an amended flood risk assessment (Nottingham City Council, 2004c). The Council rejected the Environment Agency's claims as it was felt that the development could be protected from flooding, storage for flood water could be provided and the benefits to be gained by redeveloping the site outweighed the concerns of the Environment Agency (Nottingham City Council, 2004c). However, the Environment Agency refused to withdraw its objection and a decision on the planning application was delayed for eleven months, at which point the development control committee made a decision as they felt that the delay caused by the objection was no longer acceptable (Nottingham City Council, 2005b). The Environment Agency did not object to the development at the Clearway zone but a decision was still delayed due to the Environment Agency's objection to the outline application for the whole site (Nottingham City Council, 2004b; Nottingham City Council, 2004a). The overall impact of the Environment Agency's objection was to delay the planning decision on the outline plan for the whole site and the development of the Clearway zone by at least eleven and three

months respectively but it did ensure that the development was not at risk from flooding or increase the risk of flooding elsewhere.

8.5.5 The Impact of Development Control on the Site Characterisation at the Radford Site

Brownfield REMIT/RESPONSE identified that development control had a critical impact on site characterisation and this was because, as with any development, sufficient information was required to be submitted with the planning application to the Local Authority to allow it to determine the impact that the development would have on the site, the future occupiers of the site and the area surrounding the site. The information provided focused primarily on environmental issues, specifically:

Flood risk;

Contaminated land and geotechnical risk;

Environmental impact, and;

Impact on traffic and transport.

There appears to have been little need to provide social or economic impact assessment to satisfy the council's requirement for information. The most striking example of the imbalance between the environmental assessment and the social assessment is provided by comparing the work carried out in support of the Clearway development application concerning flood risk to the work carried out to determine the impact of introducing 635 new residents including 507 students. The assessment of flood risk, which is only one aspect of assessing the environmental impact, consisted of two flood risk assessments and a report on the hydraulic modelling of the River Leen (Nottingham City Council, 2004b; Rotherman, 2004). In contrast no

information or assessments were provided to evaluate the impact of introducing the new residents.

8.6 Summary

This chapter has presented an application of Brownfield REMIT/RESPONSE to the Radford site to analyse the influence of policy on redevelopment. This has demonstrated that the Brownfield REMIT/RESPONSE approach developed in this thesis (see chapter 7) can be applied to brownfield redevelopment. The site and its redevelopment have been described using a conceptual model and a roadmap of the redevelopment process. The application of Brownfield REMIT/RESPONSE has been described and the results including the atlas of mechanisms, generic and site specific interaction matrices have been presented followed by a more detailed analysis of the policy influences identified. For a discussion of the limitations of Brownfield REMIT/RESPONSE see section 10.3.

The application of Brownfield REMIT/RESPONSE showed that policy had a critical influence on site characterisation, the general characteristics of the site and on development control at the Radford site. It has also been shown that ensuring that redevelopment meets policy objectives has caused delays within the redevelopment process.

Brownfield REMIT/RESPONSE has allowed the redevelopment of the Radford site to be analysed in a holistic manner drawing together the many complex issues into a single framework in a way that is not possible using the tools of the individual issues (such as EIA or contaminated land risk assessment). This has allowed the assessment of the redevelopment to be carried out in an integrated manner.

Chapter 9: Assessing Brownfield Redevelopment Options with Brownfield REMIT/RESPONSE

In chapter 7 Brownfield REMIT/RESPONSE was proposed as a method to assess the redevelopment of urban brownfield sites and in chapter 8 it was demonstrated that Brownfield REMIT/RESPONSE could be used to analyse brownfield redevelopment. This chapter presents the results of applying Brownfield REMIT/RESPONSE to assess and compare brownfield redevelopment options. It begins by introducing the generic interaction matrix for urban brownfield redevelopment which is used as the basis for assessing brownfield redevelopment options. The generic matrix is then applied to three sites to demonstrate how redevelopment options can be assessed and compared using Brownfield REMIT/RESPONSE.

9.1 The Generic Interaction Matrix

In this section a generic 10x10 matrix for urban brownfield redevelopment is presented that has been developed using the approach described in chapter 7. The matrix describes the interactions between the different components of the urban system that are relevant within the context of brownfield redevelopment. The ten leading components chosen for the generic brownfield redevelopment matrix are:

1. Biodiversity (BIO);
2. Natural environment (NE);
3. Built environment (BE);
4. Demographics (DEM);
5. Quality of Life (QOL);
6. Public Economic (PUE);
7. Private Economic (PRE);

8. Individual Economic (INE);
9. Local / Regional Institutional Controls (LIC), and;
10. Central / EU Institutional Controls (CIC).

The first three represent the environment, the next two social issues, the next three economic issues and the final two governance or institutional control. These leading components were selected because, in the author's opinion, they represent the key aspects of the urban area. In essence these represent the first attempt to identify the key components of an urban area and over time, as the brownfield REMIT/RESPONSE method is applied and developed further, they are likely to be refined, altered or added to.

By investigating how each component interacts with every other component the generic urban brownfield redevelopment matrix was created (Figure 69). This generic matrix took three days to produce, thus illustrating how rapidly the method can be developed to assess brownfield redevelopment. The binary coded generic urban brownfield matrix (Figure 70) represents which of the mechanisms are active within the generic urban brownfield redevelopment system and indicated that the system is quite interactive. The C,E diagram of the binary coded generic matrix (Figure 71) shows it has a mean cause and effect of 6.0 out of 10. It also shows that three of the components are dominant (central/EU institutional controls, private economic and individual economic), four are subordinate (biodiversity, natural environment, built environment, and local institutional controls) and three are balanced (demographics, quality of life and public economic). The plot shows that public economic is the most interactive component, central institutional controls and biodiversity are the least interactive, local institutional controls the most subordinate and individual economic the most dominant.

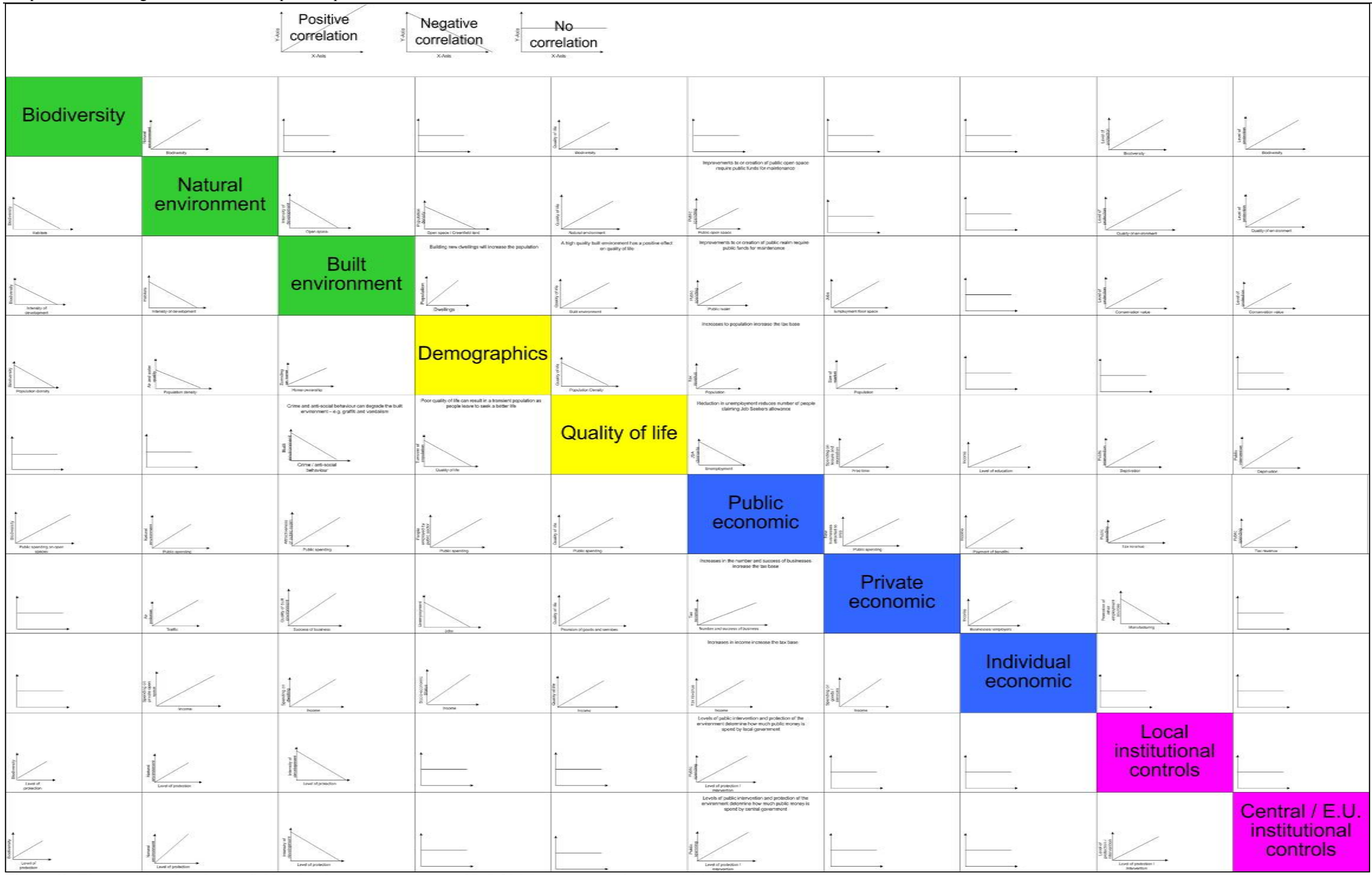


Figure 69: The generic urban brownfield redevelopment matrix (see CD-ROM for an expanded version of this figure)

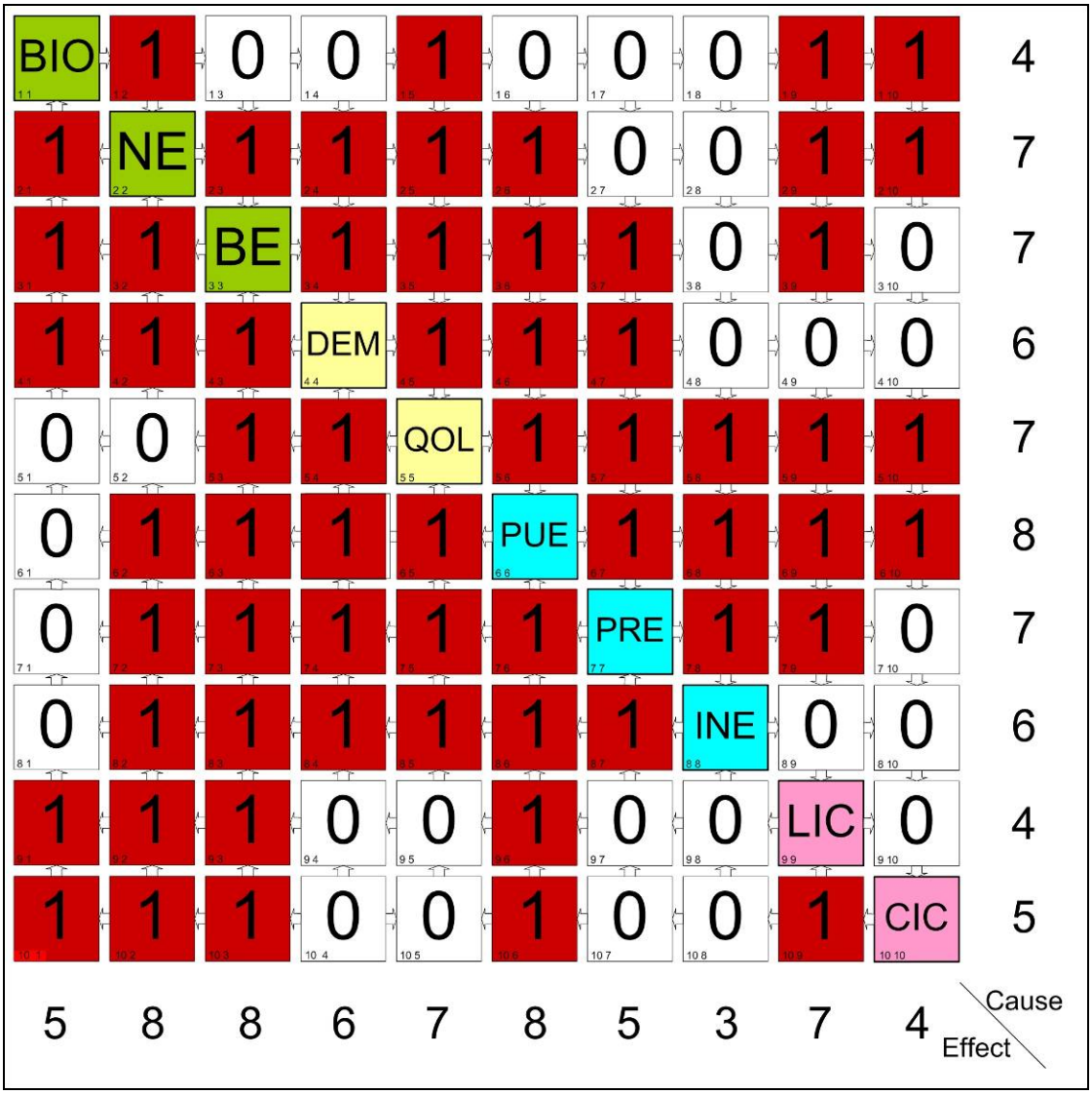


Figure 70: The binary coded generic urban brownfield redevelopment matrix

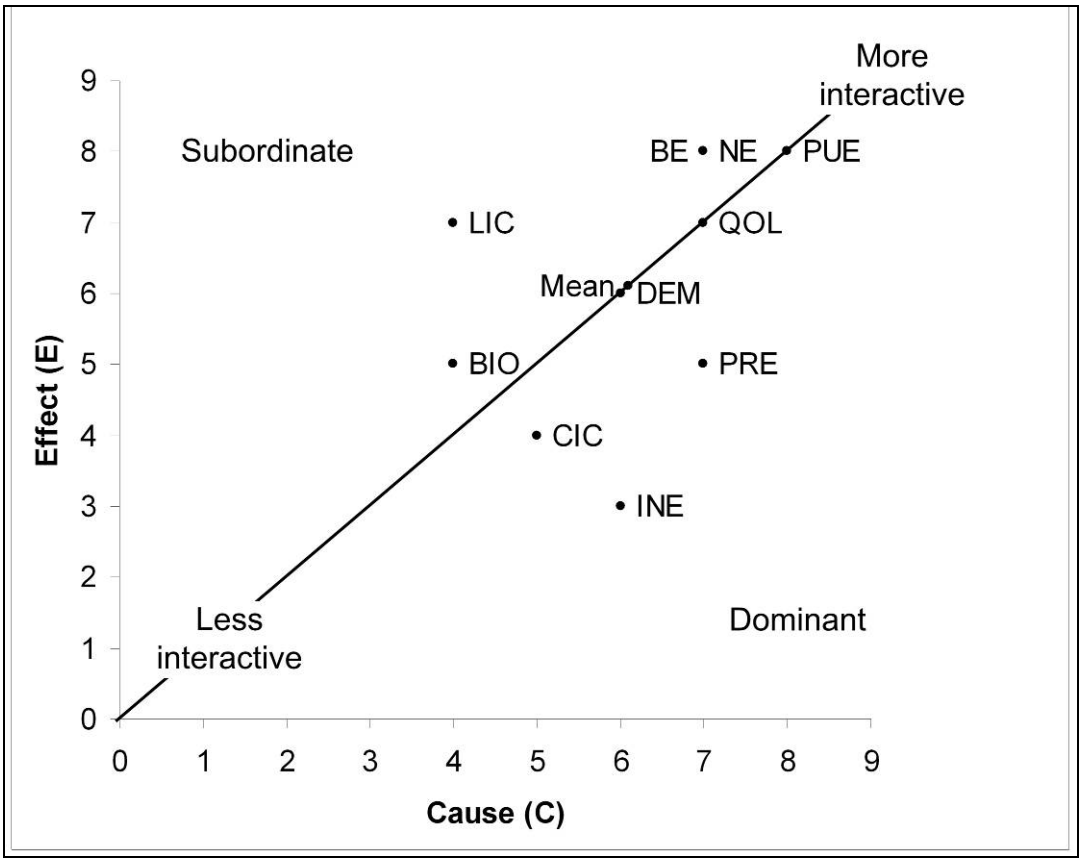


Figure 71: The C,E diagram for the binary coded generic urban brownfield redevelopment matrix

9.2 Shaw and Marvin Site, Beeston

The first site that the generic urban brownfield redevelopment matrix will be applied to is a site that is partly derelict and partly in use located in a town centre in a suburb of Nottingham. The application will only consider direct and knock-on impacts of the redevelopment

.

9.2.1 Conceptual Model of the Shaw and Marvin Site

The descriptive conceptual model of the Shaw and Marvin site (Figure 72) can be seen in Table 23 below.

Figure 72: Location of the two Beeston sites

Table 23: Descriptive conceptual model of the Shaw and Marvin site

Location	Beeston Town Centre
Local Authority	Broxtowe Borough Council
Gross Hectares	Approximately 2.5 hectares
Ownership	Tesco Stores Limited
Site boundaries	Station Road Middle Street Premises on High Road Acacia Walk The Lilacs residential complex Union Street
Current uses (prior to redevelopment)	Job Centre Social Clubs Retail unit Vehicle parts and fitting centre Vacant land Vacant dwellings
Previous uses	Dye works
Surrounding land uses	Bus station Multi-storey car park Residential properties High street and shopping centre Offices Fire station (disused)
Fit with context of larger area development	The site is located within the area for which a town centre masterplan is being developed by Broxtowe Borough Council
Planning context	Site is considered within the Broxtowe Local Plan to offer an opportunity for new development to further enhance Beeston town centre as a shopping

	centre Outline Planning Permission (03/00223/OUT) for foodstore, petrol filling station, customer and staff car park, new vehicular access and highway improvements and associated development granted July 2004 (application includes an adjacent site) Reserved matters application (04/00646/REM) relating to the development granted September 2004 Application to vary conditions (06/00194/ROC) to allow for phased construction granted September 2006
Contamination (inc any remediation carried out) (Delta Simons, 2006)	No significant widespread contamination has been identified
Transport links	Located adjacent to Beeston Bus station Good road connections Located adjacent to proposed tram route between Nottingham city centre and Chilwell
Geology (Delta Simons, 2006)	Made Ground (maximum depth of 1.2m below ground level) River Terrace Deposits (maximum proven depth of 4m below ground level Triassic Nottingham Castle Sandstone (major aquifer)
Hydrology (Flooding and drainage) (Delta Simons, 2006)	Site is not located in area of flood risk Nearest water courses are a lake 1 km north east of the site and a lake 1.3 km north of the site
Hydrogeology (Delta Simons, 2006)	Site is located upon a major aquifer with soils that are classified as having a high leaching potential During site investigation no groundwater was encountered (maximum depth of investigation was 4m bgl)
Biodiversity	Site is of limited biodiversity value
Other Issues	

9.2.2 Description of Beeston Town Centre

Beeston is the largest town and seat of local Government in the Nottinghamshire borough of Broxtowe (Table 24). The town centre is the largest shopping centre in the borough, the second largest shopping centre for comparison goods (items where choice is important including furniture, clothing etc) in South Nottinghamshire and was in 1995[8] the most significant centre for food shopping in South Nottinghamshire (Broxtowe Borough Council, 2004).

Table 24: Profile of Broxtowe Borough (2001 census data unless stated)

Population (2005)	109,100
Receiving Job seekers allowance (July 2006)	1,106 (1.6%)
VAT Registered Businesses (2005)	2,320
Indices of Deprivation Rank of Average Score (1 = most deprived, 354 =	194

[8] 1995 appears to be the last time a retail survey was carried out for Nottinghamshire so more recent data is not available

least deprived) (2004)	
Households	45,445
Owner occupied households	34,734 (76%)
Households with no cars or vans	10,638 (23%)
Residents who work at home or travel less than 2km to work	12,627 (25%)
Residents who travel 2-5km to work	11,433 (22%)
Residents who travel greater than 5km for work	25,369 (49%)
People who work in the area who travel less than 2km for work	14,101 (40%)
People who work in the area who travel less than 2-5km for work	7,440 (21%)
People who work in the area who travel greater than 5km for work	13,756 (39%)
Born outside UK	5,949 (5.5%)
People in good health	73,250 (68%)
People in fairly good health	24,554 (23%)
People in not good health	9,776 (9%)
People with a long-term limiting illness	19,522 (18%)
People that drive to work (resident population)	34,474 (67% of work journeys)
People that drive to work (those who both live and work in the area and those who work in the area)	22,902 (65% of work journeys)
People aged 16-74 with no qualifications	23,109 (29%)
People aged 16-74 with: Highest qualification attained level 1	13,287 (17%)
People aged 16-74 with: Highest qualification attained level 2	14,168 (18%)
People aged 16-74 with: Highest qualification attained level 3	5,717 (7%)
People aged 16-74 with: Highest qualification attained level 4/5	16,615 (21%)
People aged 16-74 with: Highest qualification attained other or unknown	6,291 (8%)
Total number of full-time students and schoolchildren: Aged 16-17	1,990 (2.5%)
Total number of full-time students and schoolchildren: Aged 18-74	3,845 (4.9%)

9.2.3 Redevelopment Proposal for the Shaw and Marvin Site

The site is proposed to be developed for a Tesco foodstore with gross floorspace of 5481m^2 and associated developments consisting of customer and staff car parking, new vehicular access, a tree lined walk way and highway improvements (Broxtowe Borough Council, 2003). The perturbation caused to the urban system by the proposed redevelopment of the site is illustrated in Figure 73.

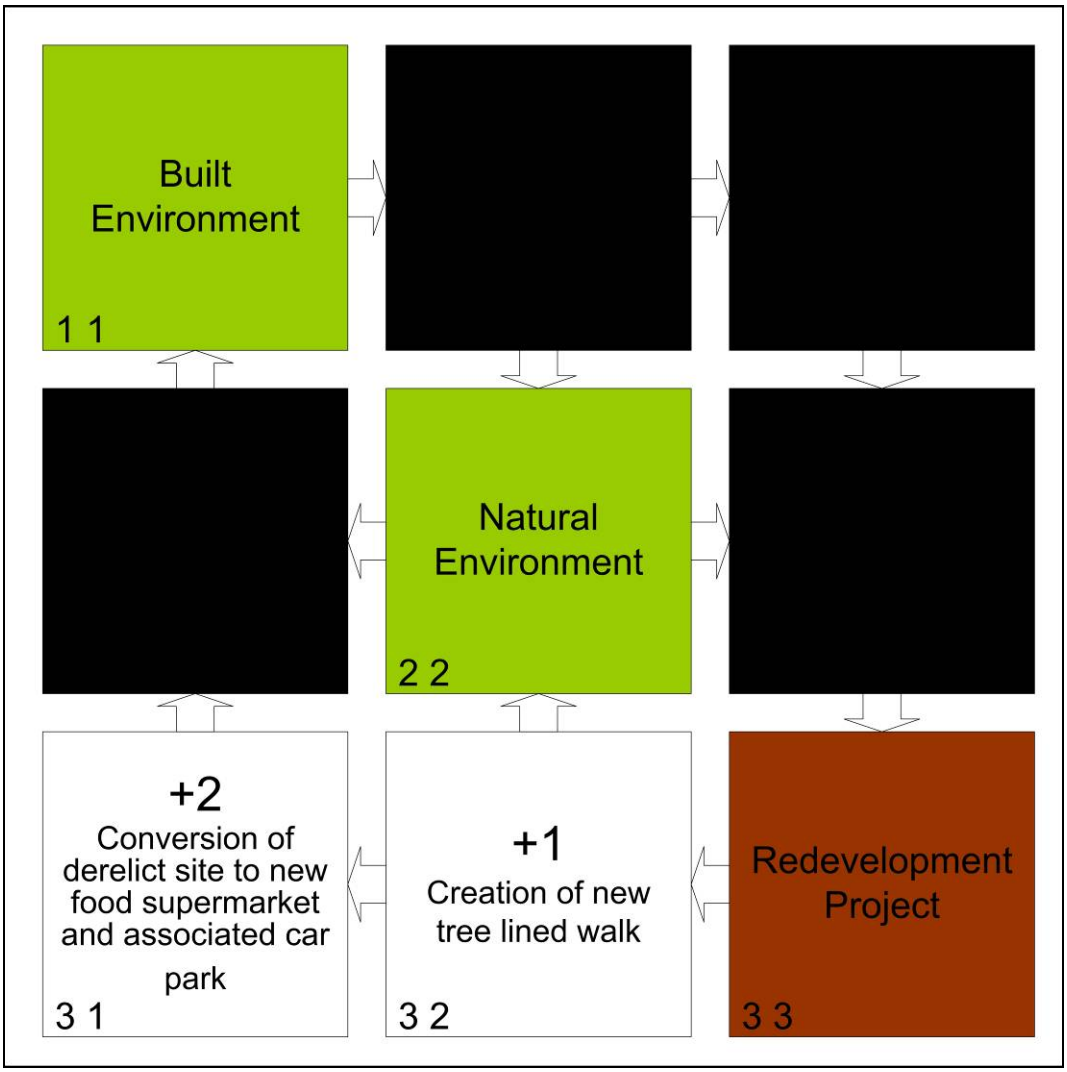


Figure 73: Perturbation caused by the proposed redevelopment of the Shaw and Marvin site

9.2.4 Assessment of the Redevelopment Proposals for the Shaw and Marvin Site Using Brownfield REMIT/RESPONSE

This assessment will focus on the direct impact of redevelopment on the urban system in Beeston town centre and the secondary responses caused by these impacts and will not include systemic responses (for an application that includes systemic responses see section 9.4). The binary coded site specific matrix shows which of the mechanisms identified in the generic matrix are active at the Shaw and Marvin site (Figure 74). The C,E diagram of the site specific binary coded matrix (Figure 75) shows it has a mean cause and effect of 3.2 which is considerably lower than the

generic matrix (6.0) indicating that it is much less interactive than the generic system. It also shows that three of the components are dominant (natural environment, built environment and private economics), six are subordinate (biodiversity, demographics, quality of life, public economics, local institutional controls and central/EU institutional controls) and only one is balanced (individual economic). The plot shows that the natural environment is the most interactive component, biodiversity, local and central institutional controls joint least interactive, quality of life most subordinate and the built environment the most dominant.

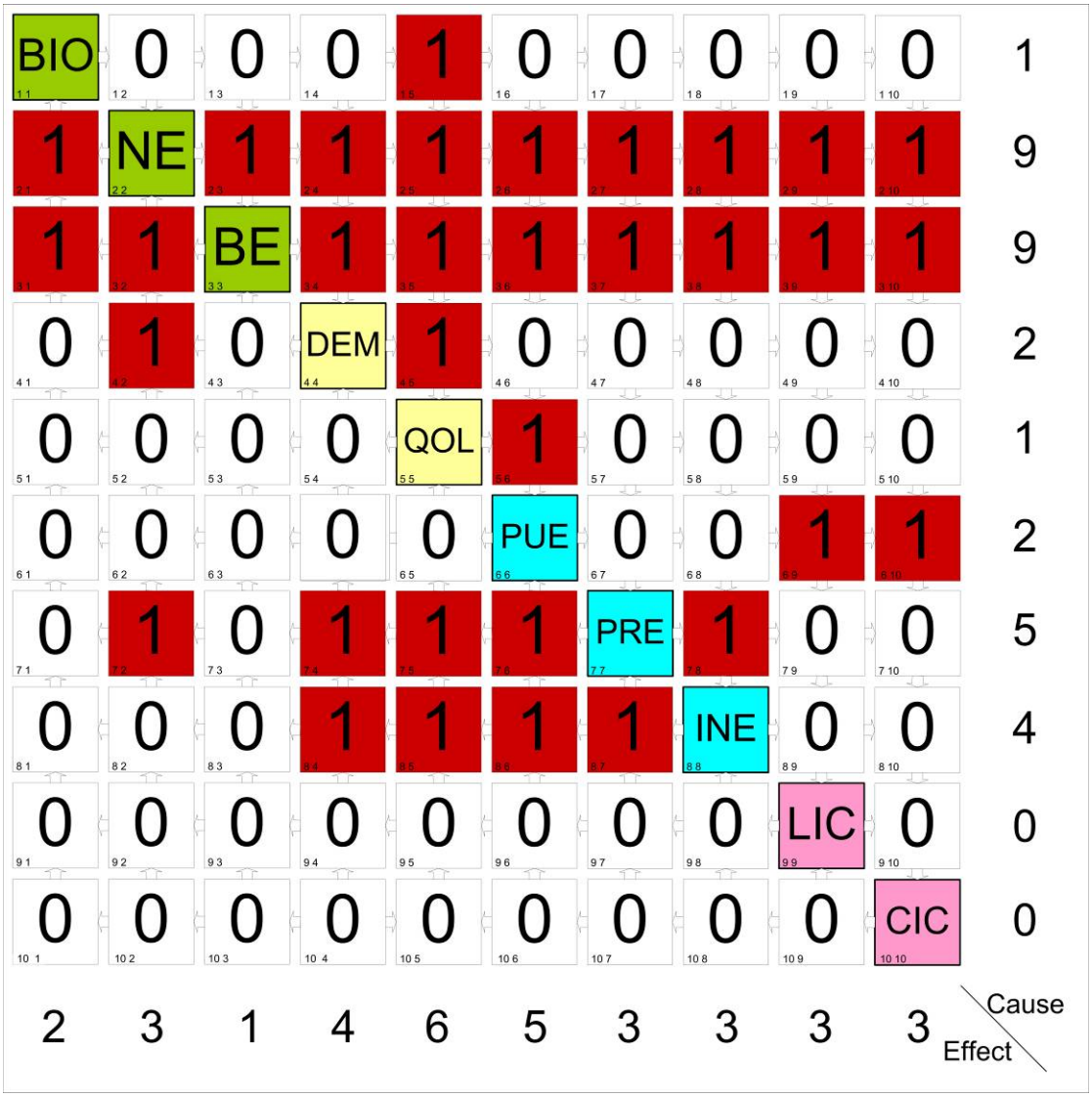


Figure 74: Binary coded site specific matrix for the Shaw and Marvin Site

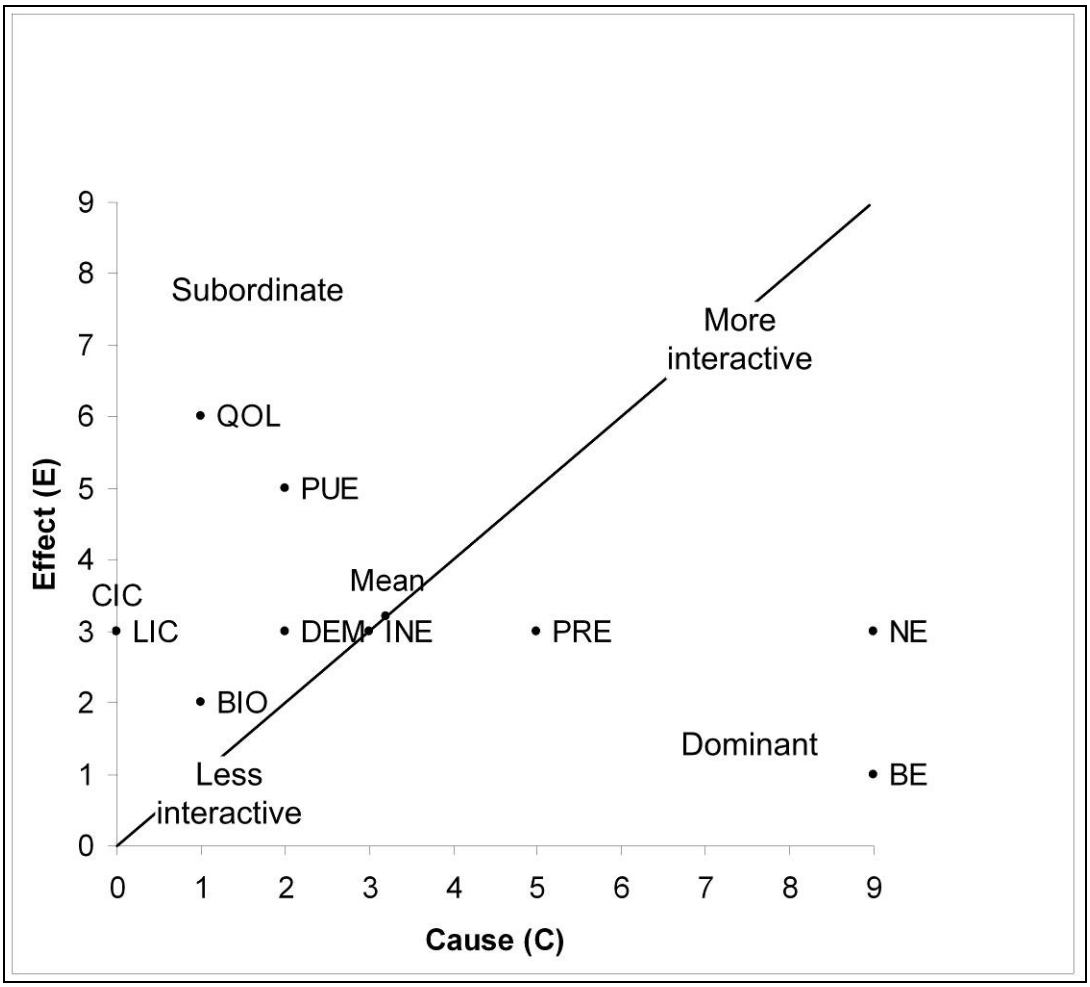


Figure 75: The C,E diagram for the binary coded site specific matrix for the Shaw and Marvin Site

The expert semi-quantitative coded site specific matrix (Figure 76) shows the impact of introducing the redevelopment proposals (section 9.2.3) as a system perturbation (see appendix B for justifications of the matrix coding). Overall Figure 76 shows that the development has more positive impacts than negative ones and all of the social and economic impacts (i.e. those on demographics, quality of life, public economic, private economic and individual economic) are positive. However, there are negative environmental impacts, albeit minor ones, and overall the environment impact is negative. The assessment concludes that redevelopment of the site for a retail store would result in five significant positive impacts, eight minor positive impacts, three minor negative impacts and no significant negative impacts. This indicates that the

redevelopment proposed is an appropriate option for the site and that perhaps some work should be carried out to mitigate the negative environmental impact.

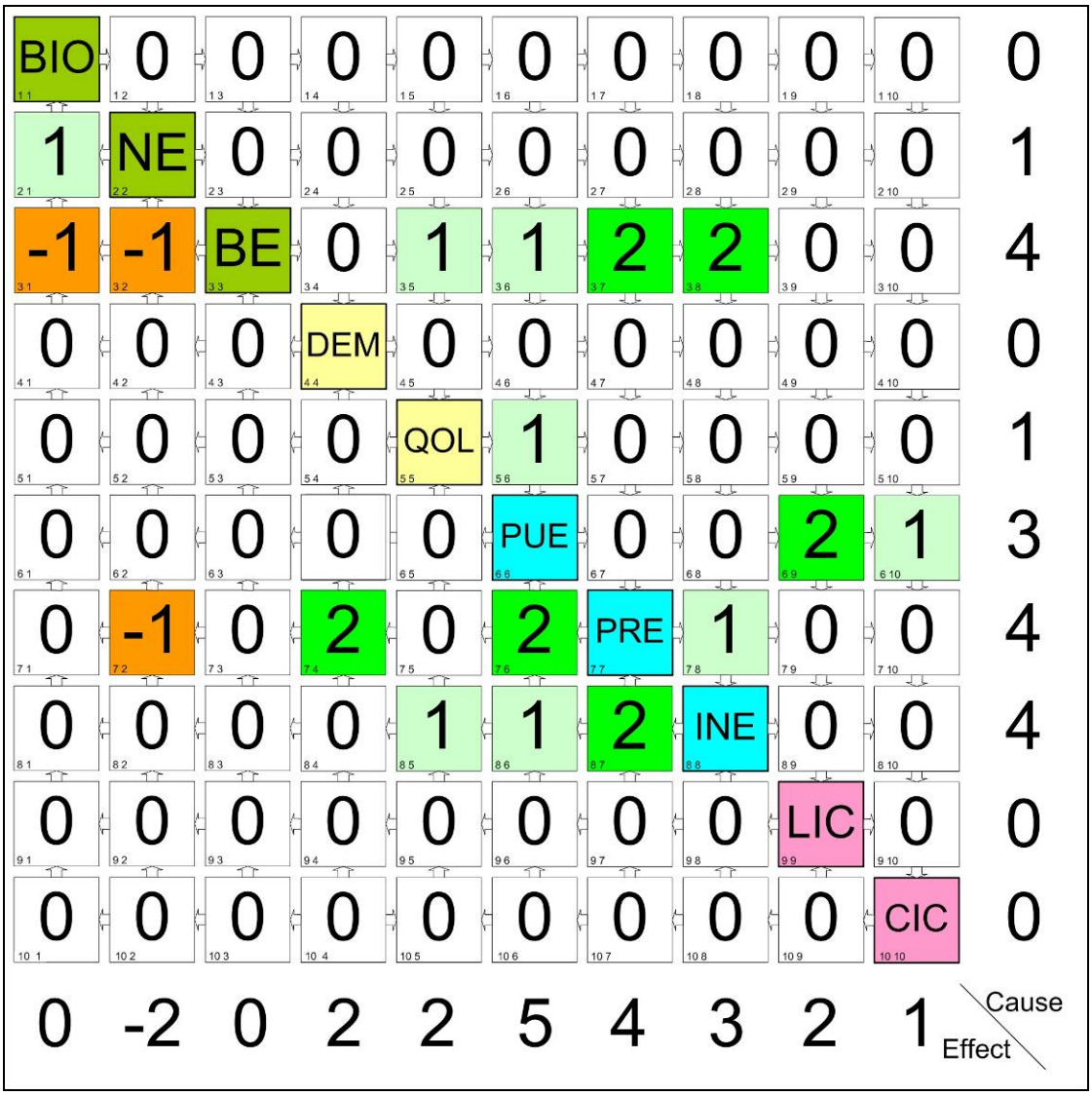


Figure 76: Expert-semi quantitative coded site specific matrix for the Shaw and Marvin site

9.3 Willoughby Garages Site, Beeston

The second site that the generic interaction matrix will be applied to is a small site that is currently in use and also located close to Beeston town centre (Figure 72). Again the application will only consider direct and knock-on impacts of the redevelopment.

9.3.1 Conceptual Model of the Willoughby Garages Site

The descriptive conceptual model of the Willoughby Garages can be seen in Table 25 below.

Table 25: Descriptive conceptual model of the land at the Willoughby Garages Site

Location	Beeston Town Centre
Local Authority	Broxtowe Borough Council
Gross Hectares	0.65 Ha
Ownership	S.Willoughby of Beeston
Site boundaries (Broxtowe Borough Council, 2006; Nicol Thomas Limited, 2006a)	Broughton Street Wollaton Road Playing fields of the Beeston Roundhill Infant and Junior School
Current uses (Arcadis GMI, 2005)	Petrol filling station, vehicle repair and maintenance workshop and car dealership
Previous uses	Similar to current use by 1938. Prior to that the site was undeveloped
Surrounding land uses (Broxtowe Borough Council, 2006)	Beeston town centre Mixed use including a school, residential properties and commercial properties. Listed Mills adjacent the site are being converted for residential development
Fit with context of larger area development	The site is located just outside the area for which a town centre masterplan is being developed by Broxtowe Borough Council
Planning context (Broxtowe Borough Council, 2006)	In planning terms, the site is just outside the boundary of Beeston town centre. Outline planning permission (06/00606/FUL) for foodstore and office building together with 89 car parking spaces refused September 2006. This decision is being appealed (APP/J3015/A/06/2029371/NWF). Full planning application (06/00970/FUL) for a revised foodstore and office building together with 100 car parking spaces submitted in November 2006.
Contamination (inc any remediation carried out) (Arcadis GMI, 2005)	Fuel tanks require decommissioning prior to redevelopment Elevated CO_2 concentrations may warrant gas protection measures in new buildings Sources of hydrocarbon identified and off-site disposal recommended as remedial action. Risk to underlying major aquifer is not considered to be high
Transport links (Turner Love Associates, 2006)	The site has good vehicle accessibility to local and wider surrounding area Direct access to the B6006 connecting to the A52 (Derby Road). The A52 connects to Nottingham city centre to the east and Junction 25 of the M1 and Derby to the west Site is within easy walking distance of a wide surrounding catchment area and also has a large residential cycling catchment. Site is well served by public transport, primarily by bus. In the future the site would be reasonably well served by a proposed tram route which will run 400m to the south of the site.
Geology (Arcadis GMI, 2005)	Made Ground (maximum depth of 1.9m below ground level) overlying sand and gravel (up to a maximum depth of 8m bgl) Bed rock was not encountered during site investigation Site is not within the zone of likely physical influence from coal mining
Hydrology (Arcadis GMI, 2005)	Nearest surface water feature is the River Trent 1.2 km to the south Site is not within a floodplain No surface water abstractions within 2km of the site

Hydrogeology (Arcadis GMI, 2005)	Underlying rocks classified as a major aquifer and the overlying soils are considered to be highly permeable 7 groundwater abstractions within 2km of the site Site is located within a Zone III (Total catchment) Source Protection Zone for a groundwater abstraction point
Biodiversity (Nicol Thomas Limited, 2006a)	There is no vegetation within the site
Other Issues	Site is currently in use

9.3.2 Description of Beeston Town Centre

The site is located in Broxtowe and is adjacent to, but lies just outside the boundary of, Beeston town centre (Broxtowe Borough Council, 2006). For a description of Beeston town centre see section 9.2.2.

9.3.3 Redevelopment Proposal for the Willoughby Garages Site

The site is proposed to be developed for a food store with a separate office block and a 100-space car park (Lidl UK GmbH, 2006). The food store is proposed to be a Lidl deep discount store with a net sales area of 1063m^2 with an ancillary storage area of 295m^2 and the office block will be a two-storey building with 400m^2 of office space. In addition parking facilities will be provided for at least nine bicycles and there will be limited areas of soft landscaping including new trees (Nicol Thomas Limited, 2006a; and 2006b). The perturbation caused to the urban system by proposed redevelopment of the site is illustrated in Figure 77.

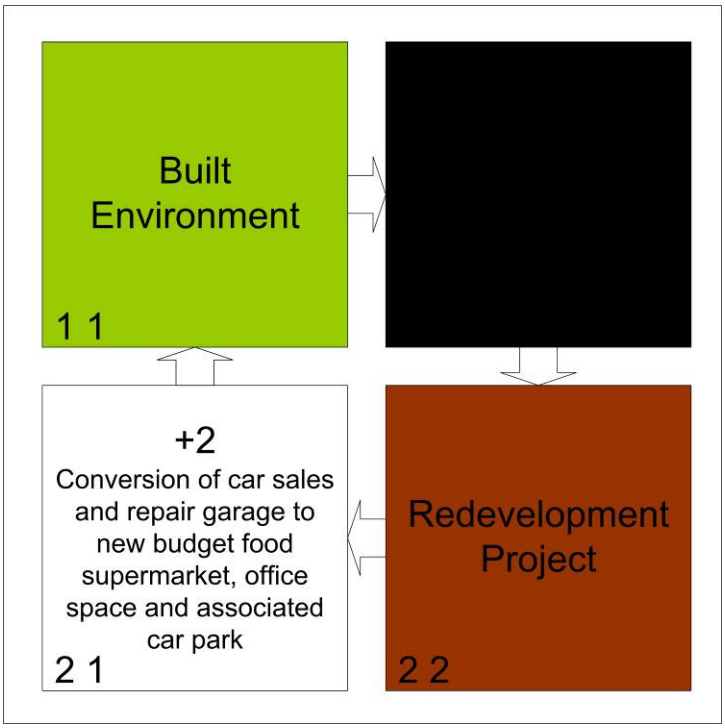


Figure 77: Perturbation caused by the proposed redevelopment of the Willoughby Garages site

9.3.4 Assessment of the Redevelopment Proposals for the Willoughby Garages Site Using Brownfield REMIT/RESPONSE

Due to the location of the site and the development proposals, the same mechanisms identified in the generic urban brownfield redevelopment matrix are active as for the Shaw and Marvin site, so it has an identical site specific binary matrix (see section 9.2.4). However, the impact of the proposed development is significantly different.

The expert semi-quantitative coded site specific matrix (Figure 78) shows that the proposed redevelopment option (section 9.3.3) will have no significant impact on the surrounding urban area (see appendix C for justifications of the matrix coding). There are more positive impacts of redevelopment than negative ones and all of the social and economic impacts are positive, however, there is one minor negative environmental impact. The assessment concludes that redevelopment of the site for a retail store would result in no significant positive impacts, eight minor positive impacts, one minor negative impact and no significant negative impacts. This

indicates that the redevelopment proposed is not inappropriate but it does suggest it will not provide much benefit to the surrounding urban area. Therefore, it is possible that a more appropriate redevelopment option for the site could be identified that would provide greater benefit to the surrounding area.

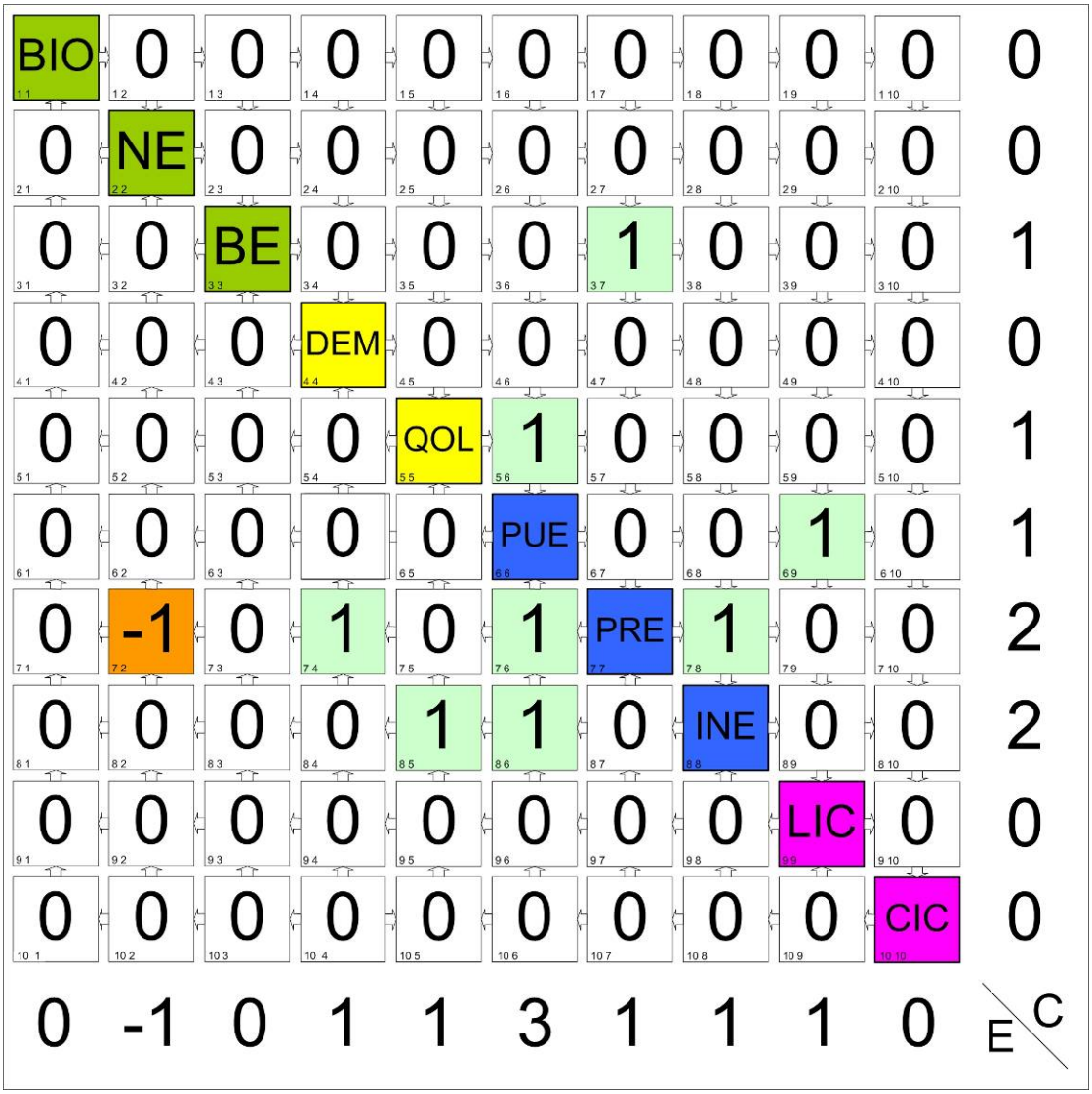


Figure 78: Expert semi-quantitative coded site specific matrix for the Willoughby Garages Site

9.4 Basford Gasworks site

The third site that the generic brownfield redevelopment matrix will be applied to is the Basford Gasworks site located in an inner suburb of Nottingham (Figure 79). Remediation of Basford Gasworks included the first large scale application of soil washing in the UK (Beck et al., 2003).

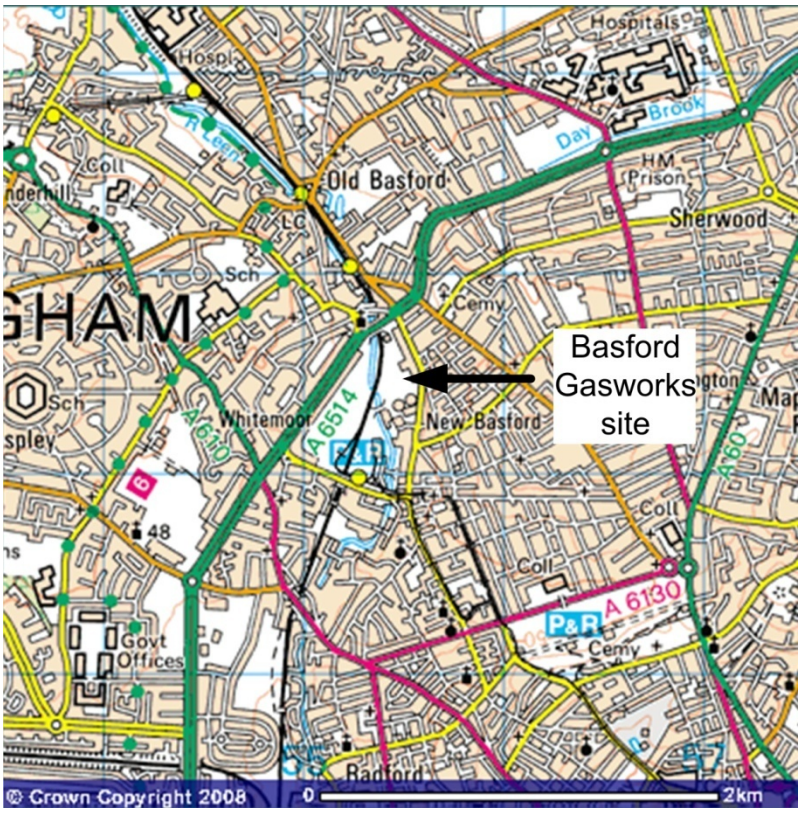


Figure 79: Location of the Basford Gasworks Site in Nottingham

9.4.1 Conceptual Model of the Basford Gasworks Site

The descriptive conceptual model of the Basford Gasworks site can be seen in Table 26 below.

Table 26: Descriptive conceptual model of the Basford Gasworks site

Location	Basford, Nottingham 2km north west of Nottingham city centre
Local Authority	Nottingham City Council
Gross Hectares (Indigo, 2005)	4.3 ha
Ownership	National Grid
Site boundaries (Indigo, 2005)	Radford Road Nottingham Express Transit line River Leen Gas holders Transco
Current uses	Vacant site
Previous uses (Indigo, 2005)	Gasworks
Surrounding land uses (Indigo, 2005)	Area characterised by a mix of uses Residential properties dominate to the north and east Diverse mix of commercial and industrial properties to the south Allotments to the west
Fit with context of larger area development	Located within the Neighbourhood Renewal Strategy area for Nottingham and an Objective 2 Community Economic Development Area making the area eligible for support under Priority 3 of the East Midlands Objective 2 Programme, a European funding programme, which runs from 2000 to

	2008
Planning context (Nottingham City Council, 2001; and 2005c)	Outline planning permission (05/02478/Pout) for mixed use development conditionally granted in August 2006 Application relating to reserved matters not yet submitted Site identified in the Nottingham Local Plan for development for predominantly industrial uses with enabling uses if necessary Site specific planning brief published April 2001
Contamination (inc any remediation carried out) (Indigo, 2005; Komex, 2005b)	Majority of the site has been remediated to a standard suitable for commercial and industrial uses using soil washing techniques Residual sources of contamination that were practically unfeasible to remove remain on site Free phase coal tar exists within occasional fractures of the sandstone up to a depth of 38m Elevated areas of PAHs and lead near the eastern boundary of the site Elevated concentrations of PAHs, phenols, BTEX compounds, ammonium, cyanide and some heavy metals have been detected in groundwater with the Sherwood Sandstone and overlying deposits Risk assessment has shown there could be risks to future residents and mitigation measures would be required for residential development
Transport links (Indigo, 2005)	Site is well connected Direct road links to Nottingham's ring road and on to the M1 Good public transport links including bus and tram connections, with the potential for a new tram stop on site in the future Large cycle-in and walk-in residential catchment areas
Geology (Komex, 2005b)	Made Ground (1-5m thick in unremediated areas, up to 9m in remediated areas) Alluvial sand and gravel (4m thick) Sherwood sandstone (40m thick) Non-fractured Lower Magnesian Limestone (>2m thick)
Hydrology (Komex, 2005a; and 2005b)	Site lies partially in the flood plain of the River Leen but the majority of the site is above the 100 year modelled flood level Increased surface run off is considered to be a particular problem as the River Leen is already over capacity Water quality of the River Leen is rated as fairly good 2 licensed surface water abstractions for industrial purposes between 500m and 800m downstream from the site
Hydrogeology (Komex, 2005b)	Groundwater is present within the Made Ground, alluvial deposits and Sherwood sandstone. Lower Magnesian Limestone is likely to act as an aquitard between the Sherwood sandstone and the deeper limestone aquifer 9 abstraction wells within a 2km radius of the site (8 industrial, one disused public water supply)
Biodiversity (WSP, 2005)	Water vole activity along the River Leen SINC (site of interest for nature conservation) adjacent to the site Trees, amenity planting and scattered shrubs may provide nesting opportunities for birds that are protected during nesting season (typically March to July) and it is possible that a number of common species could nest on the site An area of Japanese knotweed was recorded in the south west corner of the site

9.4.2 Description of the Area Surrounding the Basford Gasworks

The site is located in one of the most socially excluded areas of Nottingham (Indigo, 2005). It is located on the boundary between Berridge and Basford wards and these

will be used as the basis for creating a profile of the surrounding urban area using 2001 census data (Table 27).

Table 27: Profile of the Berridge and Basford area of Nottingham (all figures for 2001 except where stated)

Population	31234
Households	13566
Household spaces	14251
Dwelling vacancy rate	4.8%
Working age population (January 2007)	20444
Receiving Job seekers allowance (January 2007)	920 (4.5%)
All People Aged 16 to 74 in Employment in Area	13163
Residents who work at home or travel less than 2km to work	3742 (29%)
Residents who travel 2-5km to work	4936 (39%)
Residents who travel greater than 5km for work	3680 (29%)
People who work in the area who travel less than 2km for work	3804 (29%)
People who work in the area who travel less than 2-5km for work	3730 (28%)
People who work in the area who travel greater than 5km for work	5629 (43%)
Households with no car	5762 (42%)
Households with 1 car	5839 (43%)
Households with 2 or more cars	1967 (14%)
Total number of cars	10169 (1 per every 1.3 households)
Born outside UK	3670 (12%)
People in good health	20573(66%)
People in fairly good health	7386 (24%)
People in not good health	3276 (10%)
People with a long-term limiting illness	5882 (18%)
People that drive to work (resident population)	6737 (30%)
People that drive to work (those who both live and work in the area and those who work in the area)	9040 (39%)
People aged 16-74 with no qualifications	7251 (32%)
People aged 16-74 with: Highest qualification attained level 1	3315 (15%)
People aged 16-74 with: Highest qualification attained level 2	3647 (16%)
People aged 16-74 with: Highest qualification attained level 3	2640 (12%)
People aged 16-74 with: Highest qualification attained level 4/5	4557 (20%)
People aged 16-74 with: Highest qualification attained other or unknown	1194 (5%)
Total number of full-time students and schoolchildren: Aged 16-17	608 (3%)
Total number of full-time students and schoolchildren: Aged 18-74	2296 (10%)
Rate of out-migration per 1,000 persons population from mid-2000 to mid-2001	124
Rate of in-migration per 1,000 persons population from mid-2000 to mid-2001	113

9.4.3 Redevelopment Objectives for the Basford Gasworks Site

Nottingham City Council's objectives for the Basford Gasworks site are that:

The site is redeveloped;

Jobs are created, and;

The jobs created are well paid and suitable for local residents (Nottingham City Council, 2001; Nottingham City Council, 2005c).

9.4.4 Redevelopment Options for the Basford Gasworks Site

Three possible redevelopment options for the redevelopment of the Basford Gasworks sites were assessed using Brownfield REMIT/RESPONSE:

1. Industrial and commercial units;
2. Food retail superstore, and;
3. Residential development.

These options are hypothetical but are considered by the author to be indicative of possible uses for the site. The site does have outline planning permission for a mixed use scheme and, although this is not assessed, the layout from this is used as the basis for each of the options: all that is considered to vary between the options is the type of building that will be built. Therefore, the assessment has focused on the impacts arising from the land use option chosen, not from the impact of the scale of development (e.g. amount of site built on) or layout of the site. In essence this means that the assessment focused on what the impacts of redeveloping the site for each use will be on the surrounding area. A description of each of the proposed developments is given below (Table 28). The perturbation caused to the urban system by each of the redevelopment proposals are shown in Figure 80, Figure 81 and Figure 82.

Table 28: Redevelopment options for the Basford Gasworks site

Redevelopment option	Description
A. Industrial and commercial units	Industrial and business units with a total B1 (general business) floor space 3300m^2 and 11700m^2 of B2/B8 (General industrial/ storage and distribution)
B. Food retail superstore	Food superstore with 9000m^2 of sales space
C. Family housing	200 2-, 3- and 4-bedroom dwellings

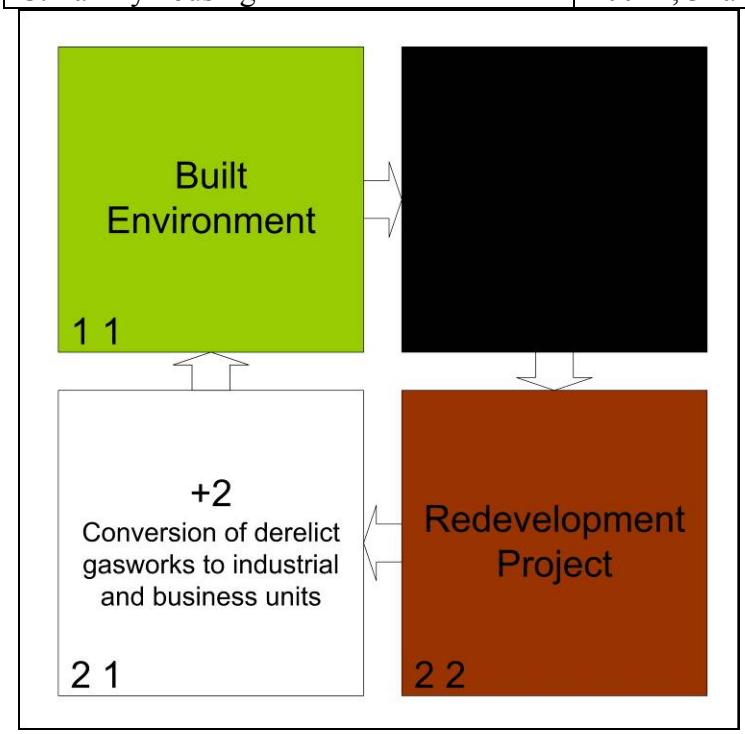


Figure 80: Perturbation caused by the proposed redevelopment of the Basford Gasworks site for industrial and commercial units

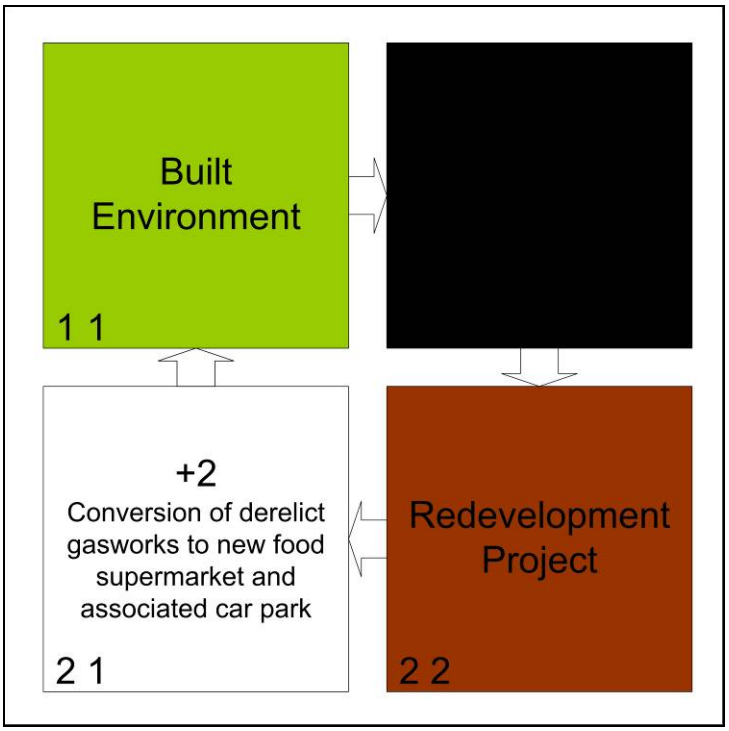


Figure 81: Perturbation caused by the proposed redevelopment of the Basford Gasworks site for a food retail superstore

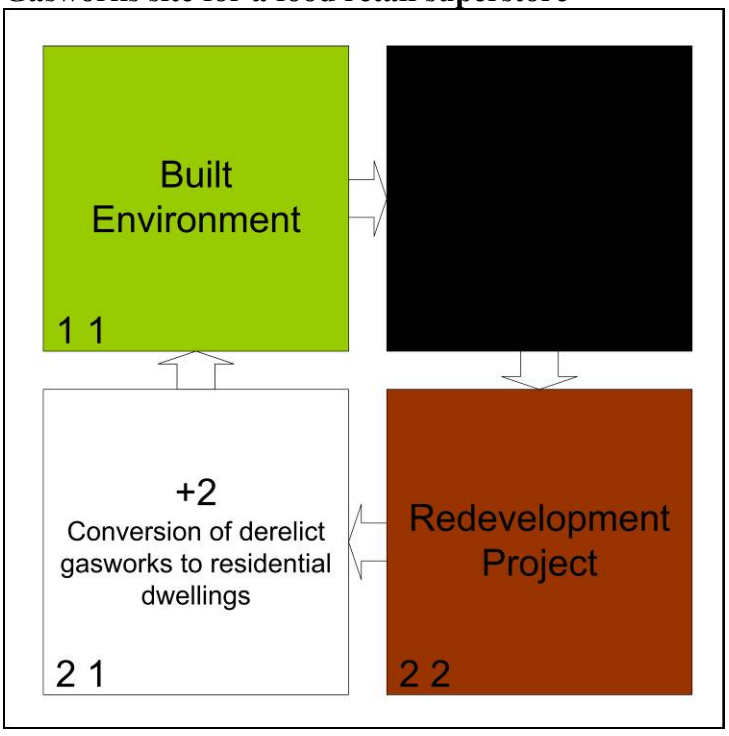


Figure 82: Perturbation caused by the proposed redevelopment of the Basford Gasworks site for family housing

9.4.5 Assessment of the Redevelopment Options for the Basford Gasworks Site Using Brownfield REMIT/RESPONSE

The application of Brownfield REMIT/RESPONSE to Basford Gasworks will include systemic effects of redevelopment as well as direct and knock-on effects. The binary coded site specific matrix shows which of the mechanisms identified in the generic matrix are active at the Basford Gasworks site if the site is redeveloped for industrial and business units (Figure 83). The C,E diagram of the site specific binary coded matrix (Figure 84) shows it has a mean cause and effect of 2.4 which is considerably lower than the generic matrix (6.0) indicating that it is much less interactive than the generic system. It also shows that four of the components are dominant (individual economics, quality of life, built environment and private economics), five are subordinate (biodiversity, demographics, public economics, local institutional controls and central/EU institutional controls) and only one is balanced (natural environment). The plot shows that public economics, the built environment and quality of life are joint most interactive components, biodiversity and central institutional controls joint least interactive, public economics most subordinate and individual economics the most dominant.

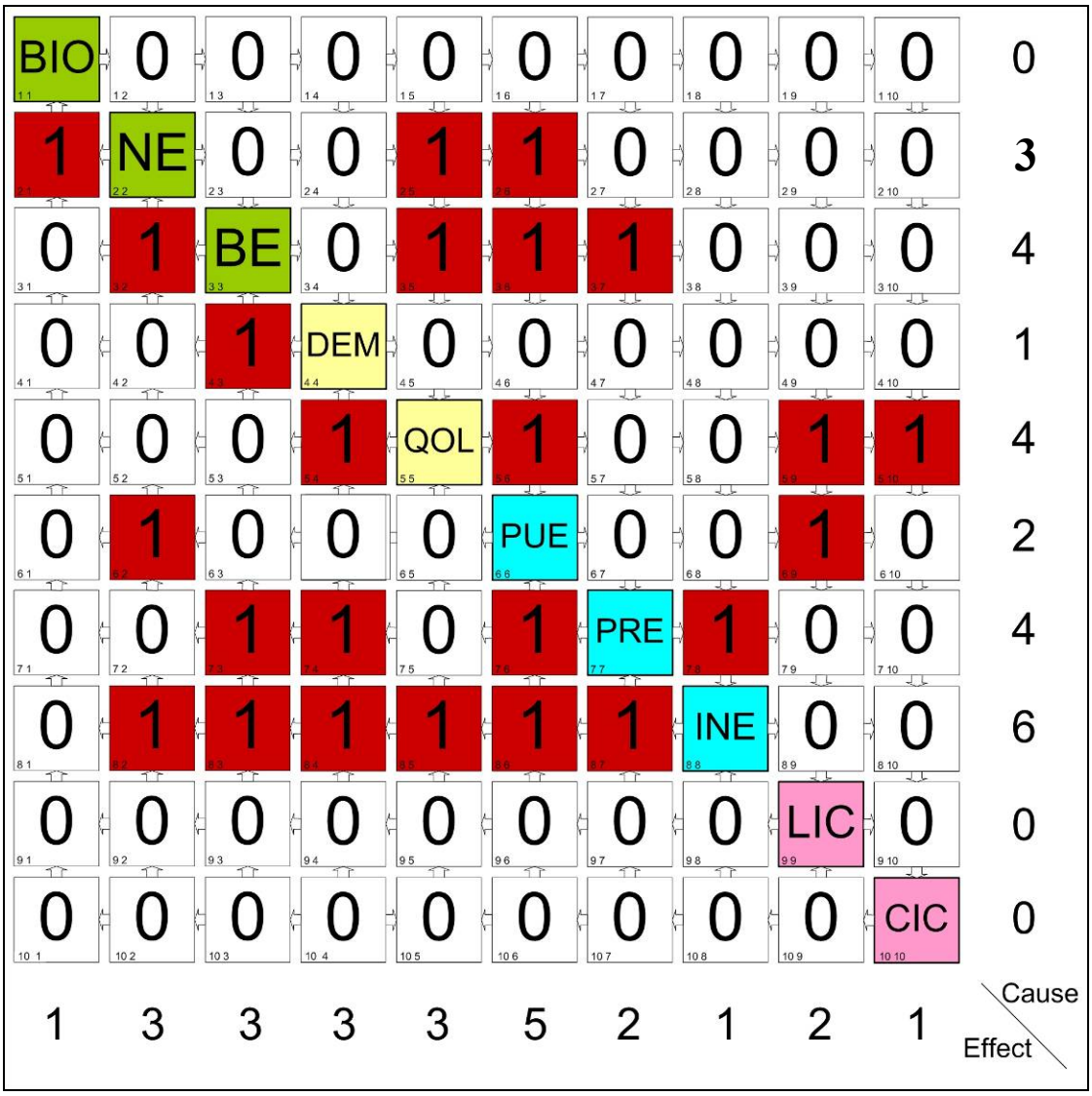


Figure 83: The binary coded site specific matrix for the redevelopment of the Basford Gasworks site for industrial and commercial units

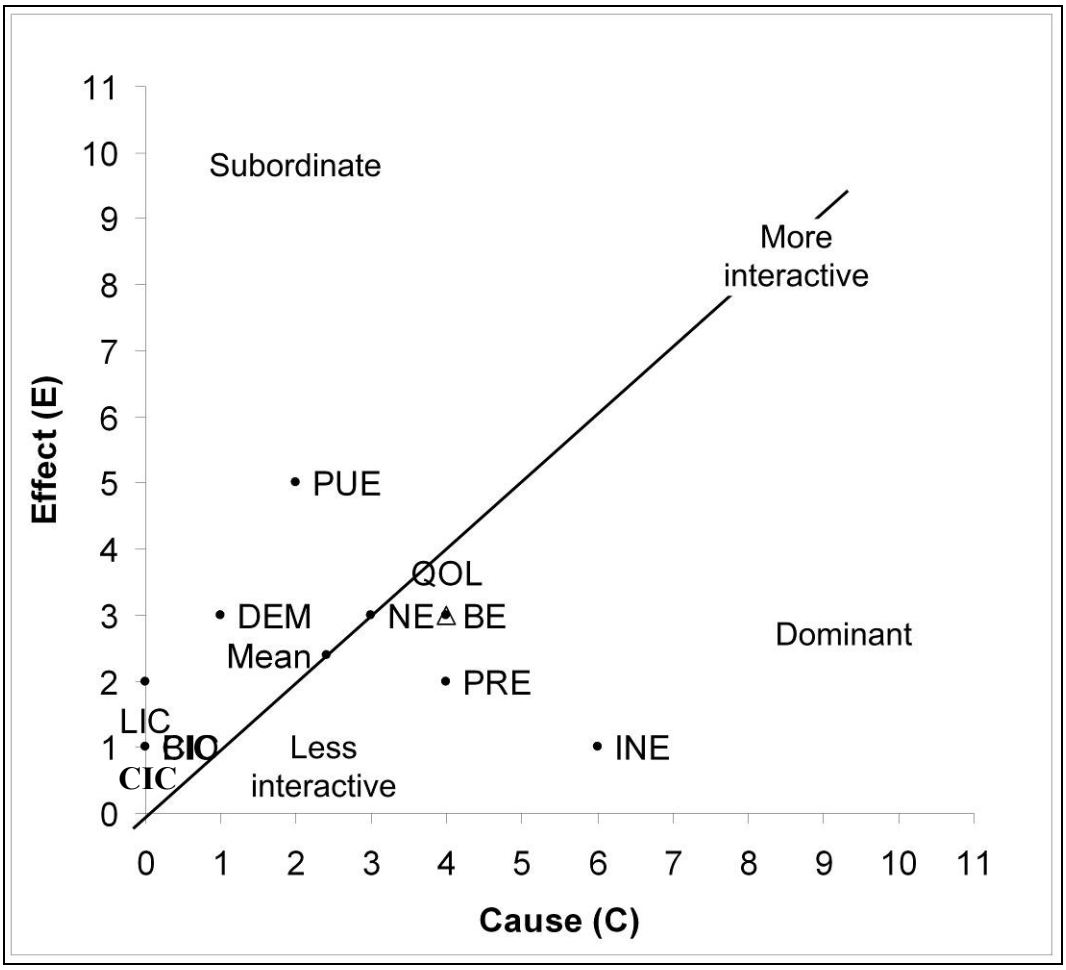


Figure 84: The C,E diagram for the binary coded site specific matrix for the redevelopment of the Basford Gasworks site for industrial and commercial units

The expert semi-quantitative coded site specific matrix for the redevelopment of the site for industrial and commercial units (Figure 85) shows that the proposed redevelopment option will have a wide range of impacts on the surrounding urban area (see appendix D, table A for justifications of the matrix coding). Of most importance, the development will have a significant positive impact on private economic (new employment generating land uses and increased market due to increased spending power of those with new jobs), individual economic (new jobs and increased incomes), quality of life (better quality of life for those with new jobs), demographics (reduced unemployment) and public economics (reduced job seekers allowance payments). There are far more positive impacts of redevelopment than negative ones and both negative impacts are related to the increased public spending

required to maintain the public realm and public open space. The assessment concludes that redevelopment of the site for industrial and commercial units would result in six significant positive impacts, thirteen minor positive impacts, two minor negative impacts and no significant negative impacts. This indicates that the redevelopment proposed is appropriate but that extra public funds may have to be budgeted for the maintenance of the public realm and public open space.

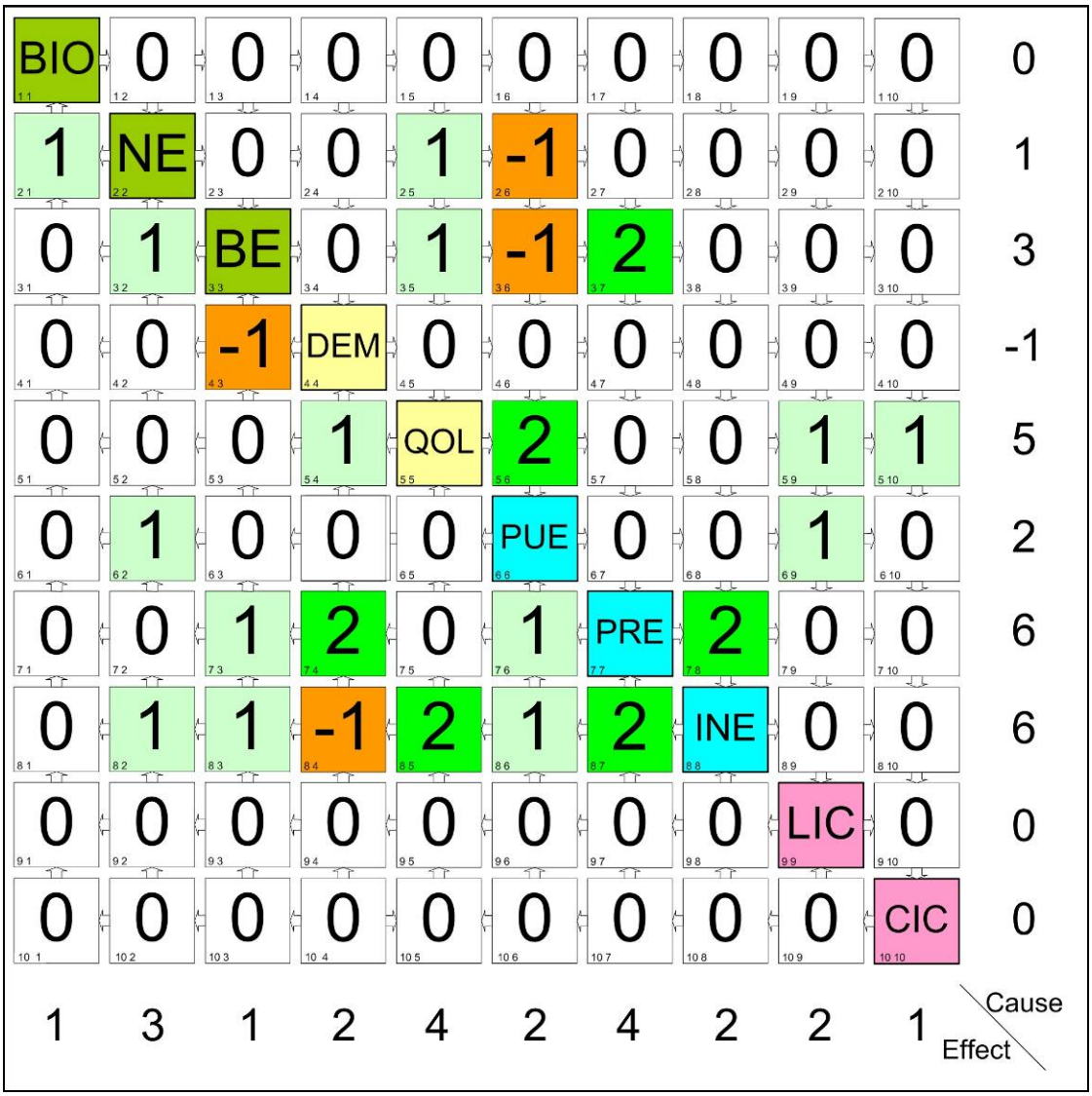


Figure 85: The expert-semi quantitative coded site specific matrix for the redevelopment of the Basford Gasworks site for industrial and commercial units

The binary coded site specific matrix shows which of the mechanisms identified in the generic matrix are active at the Basford Gasworks site if the site is redeveloped for a food supermarket (Figure 86). The C,E diagram of the site specific binary coded

matrix (Figure 87) shows it has a mean cause and effect of 3.1 which is considerably lower than the generic matrix (6.0) indicating that it is much less interactive than the generic system. It also shows that three of the components are dominant (individual economics, built environment and private economics), five are subordinate (natural environment, biodiversity, public economics, local institutional controls and central/EU institutional controls) and two are balanced (quality of life and demographics). The plot shows that quality of life is the most interactive component, biodiversity and central institutional controls joint least interactive, public economics most subordinate and individual economics the most dominant.

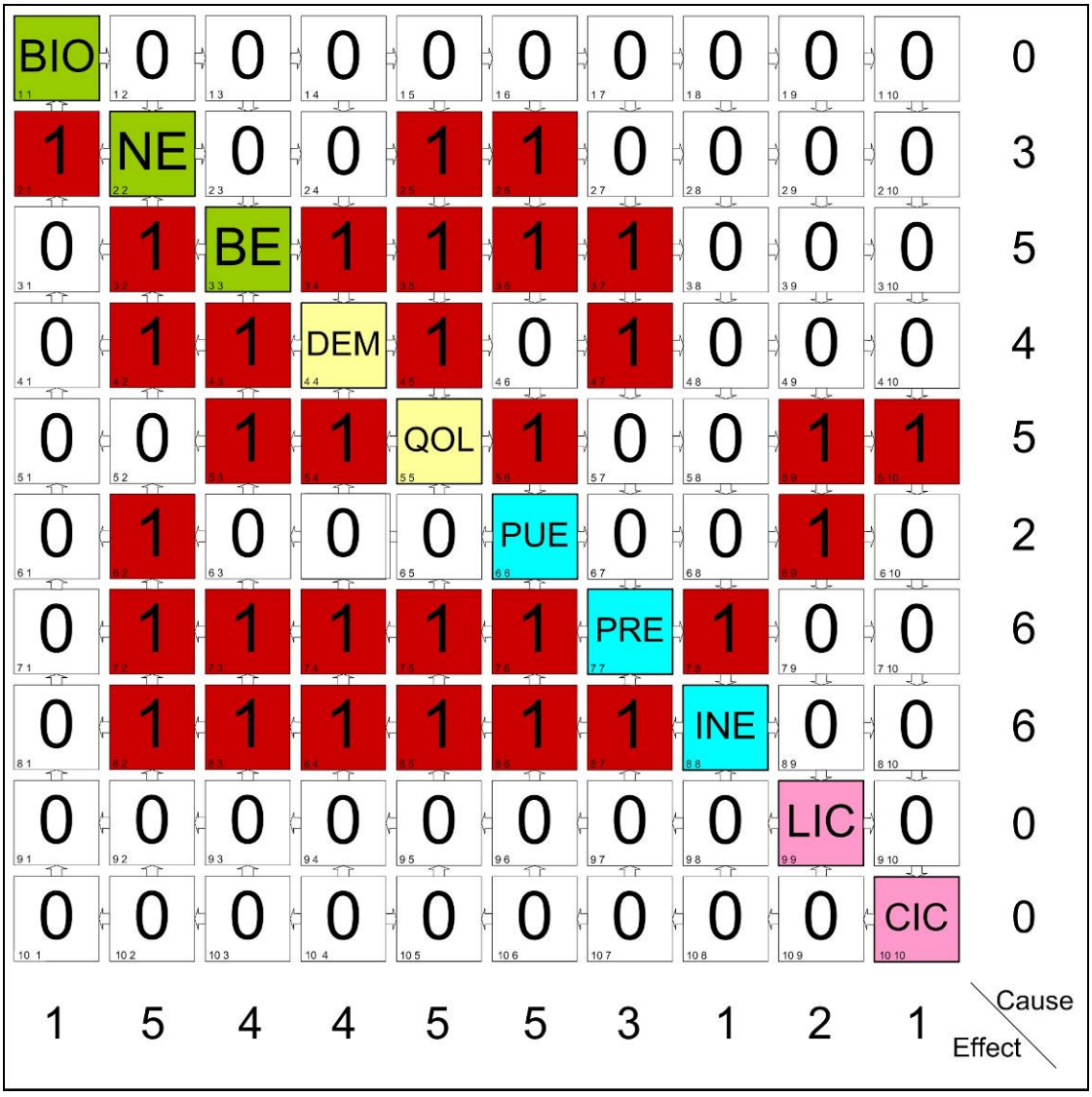


Figure 86: The binary coded site specific matrix for the redevelopment of the Basford Gasworks site for a food supermarket

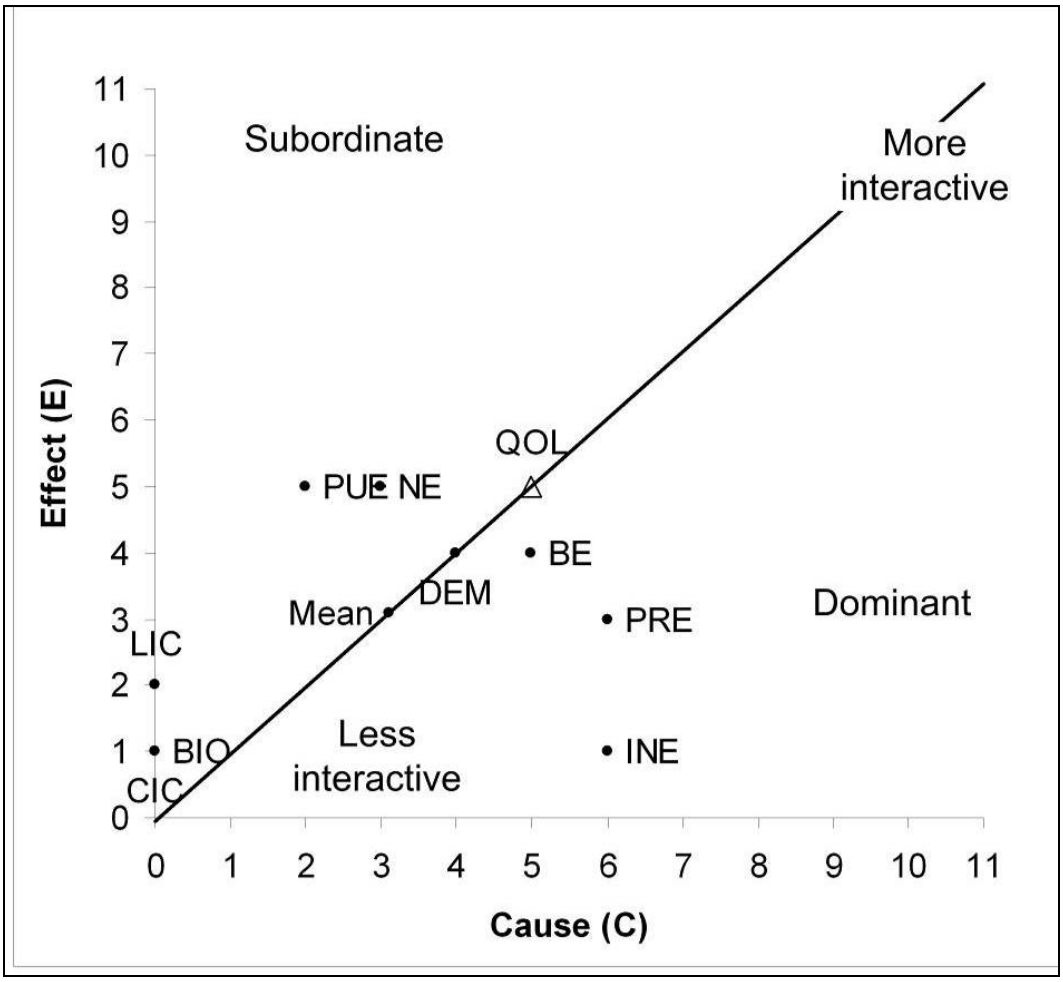


Figure 87: The C,E diagram for the binary coded site specific matrix for the redevelopment of the Basford Gasworks site for a food supermarket

The expert semi-quantitative coded site specific matrix for the redevelopment of the site for a food superstore (Figure 88) shows that the proposed redevelopment option will have a number of significant impacts, both positive and negative (see appendix D, table B for justifications of the matrix coding). The assessment of the food superstore redevelopment option identified two significant direct impacts of development: an increase in road traffic and the creation of 470 new jobs. An increase in traffic has been shown to have a significant systemic effect on urban areas which can result in loss of flora and fauna, adverse health effects, the creation of 'fresh food deserts', increased carbon dioxide emissions, adverse economic impacts and even flash flooding (Royal Commission on Environmental Pollution, 2007). The creation of jobs is likely to increase household incomes for some households within the area and this

has been shown to have a number of systemic effects within urban areas including rising rents and property values, upgrading of homes, out-migration and rising vacancy rates (Grigsby et al., 1987). However, the significance of these systemic effects will be reduced as the jobs created are likely to be low paid. A reduction in the number of job seekers allowance claimants is also likely due to the creation of jobs. There are far more positive impacts of redevelopment than negative ones and both negative impacts relate to the increased public spending required to maintain the public realm and public open space. The assessment concludes that redevelopment of the site for a food superstore would result in two significant positive impacts, sixteen minor positive impacts, ten minor negative impacts and two significant negative impacts. This indicates that the redevelopment proposed is inappropriate because although the objective to create new jobs will be met, the objectives that they are well paid will not be met and the development will result in two significant negative impacts and an array of minor negative impacts.

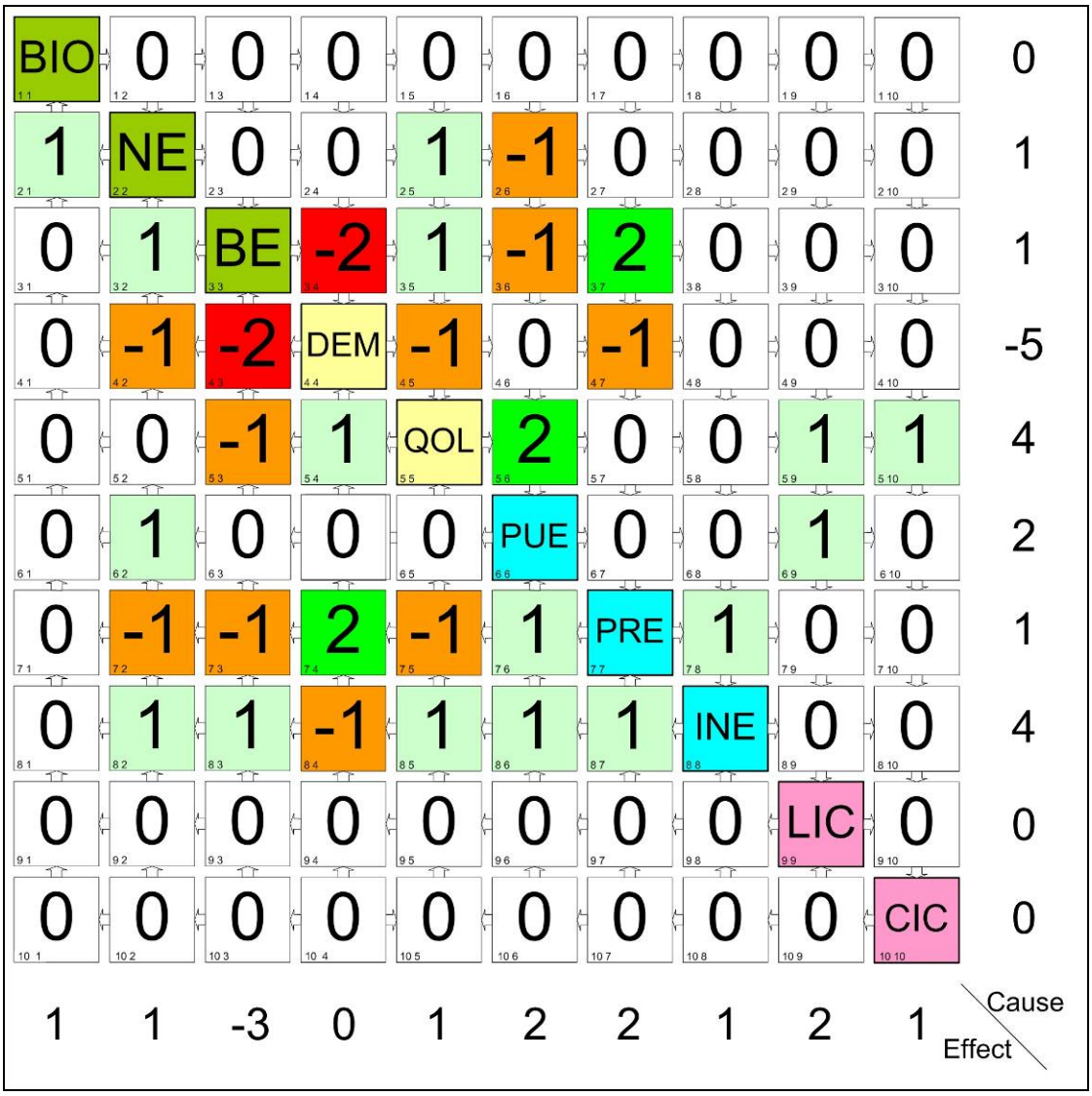


Figure 88: The expert-semi quantitative coded site specific matrix for the redevelopment of the Basford Gasworks site for a food superstore

The binary coded site specific matrix shows which of the mechanisms identified in the generic matrix are active at the Basford Gasworks site if the site is redeveloped for family housing (Figure 89). The C,E diagram of the site specific binary coded matrix (Figure 90) shows it has a mean cause and effect of 1.1 which is considerably lower than the generic matrix (6.0) indicating that it is much less interactive than the generic system. It also shows that three of the components are dominant (natural environment, individual economics, built environment and demographics), four are subordinate (biodiversity, quality of life, private economics, and public economics) and three are balanced (individual economics, local institutional controls and central/EU

institutional controls). The plot shows that the built environment is most interactive components, individual economics, local institutional controls and central/EU institutional controls joint least interactive, quality of life and public economics joint most subordinate and built environment the most dominant.

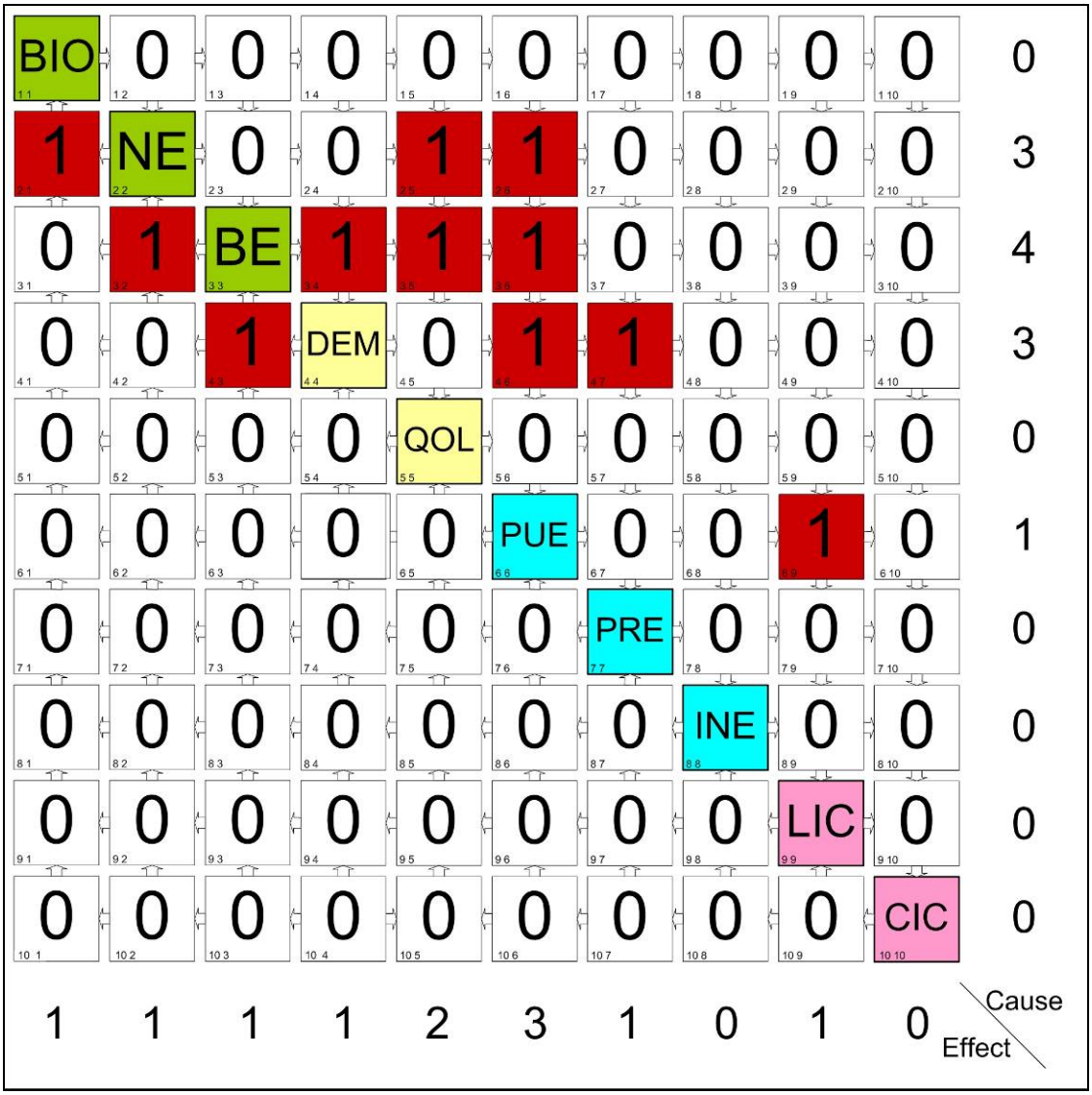


Figure 89: The binary coded site specific matrix for the redevelopment of the Basford Gasworks site for housing

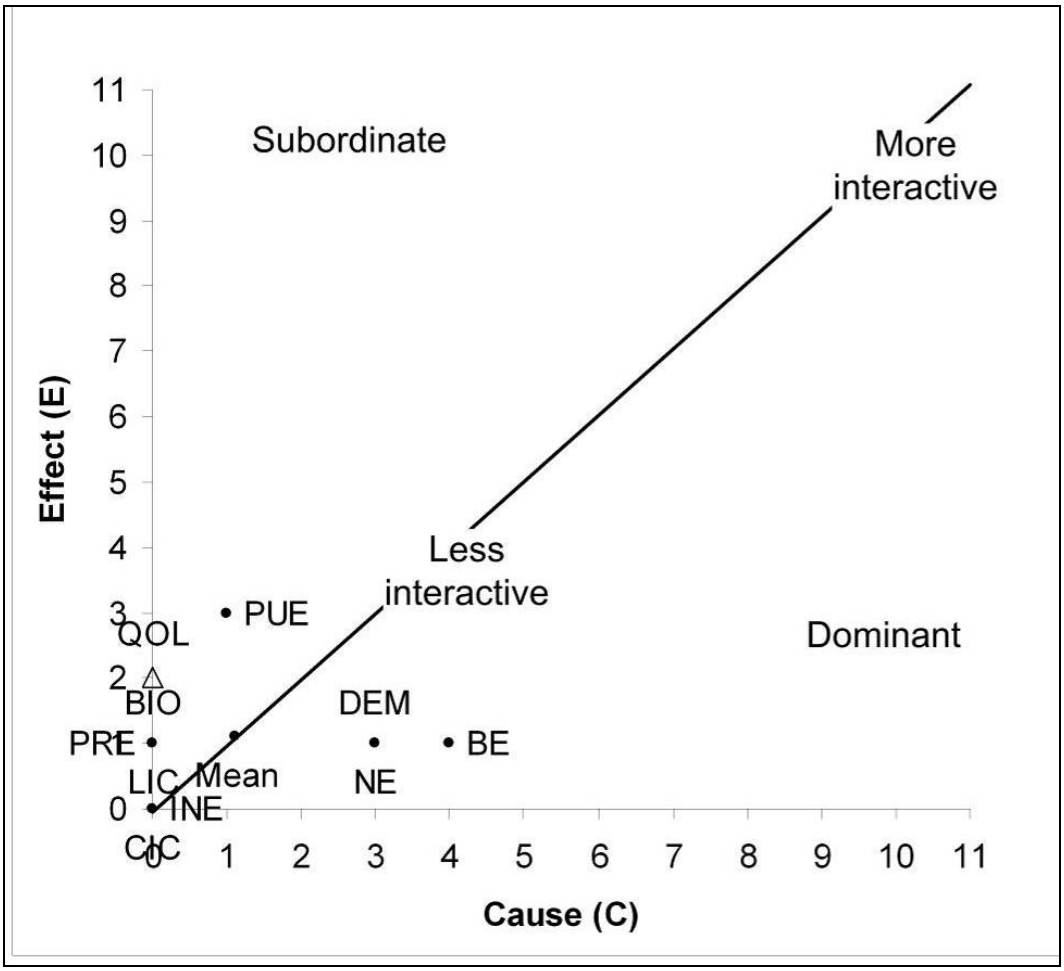


Figure 90: The C,E diagram for the binary coded site specific matrix for the redevelopment of the Basford Gasworks site for a food supermarket

The expert semi-quantitative coded site specific matrix for the redevelopment of the site for housing (Figure 91) shows that the proposed redevelopment option will have no significant impact on the surrounding urban area (see appendix D, table C for justifications of the matrix coding). There are more positive impacts of redevelopment than negative ones and both negative impacts relate to increased public spending required to maintain the public realm and public open space. The assessment concludes that redevelopment of the site for housing would result in no significant positive impacts, nine minor positive impacts, two minor negative impacts and no significant negative impacts. This indicates that the redevelopment proposed is inappropriate as the objectives will not be met.

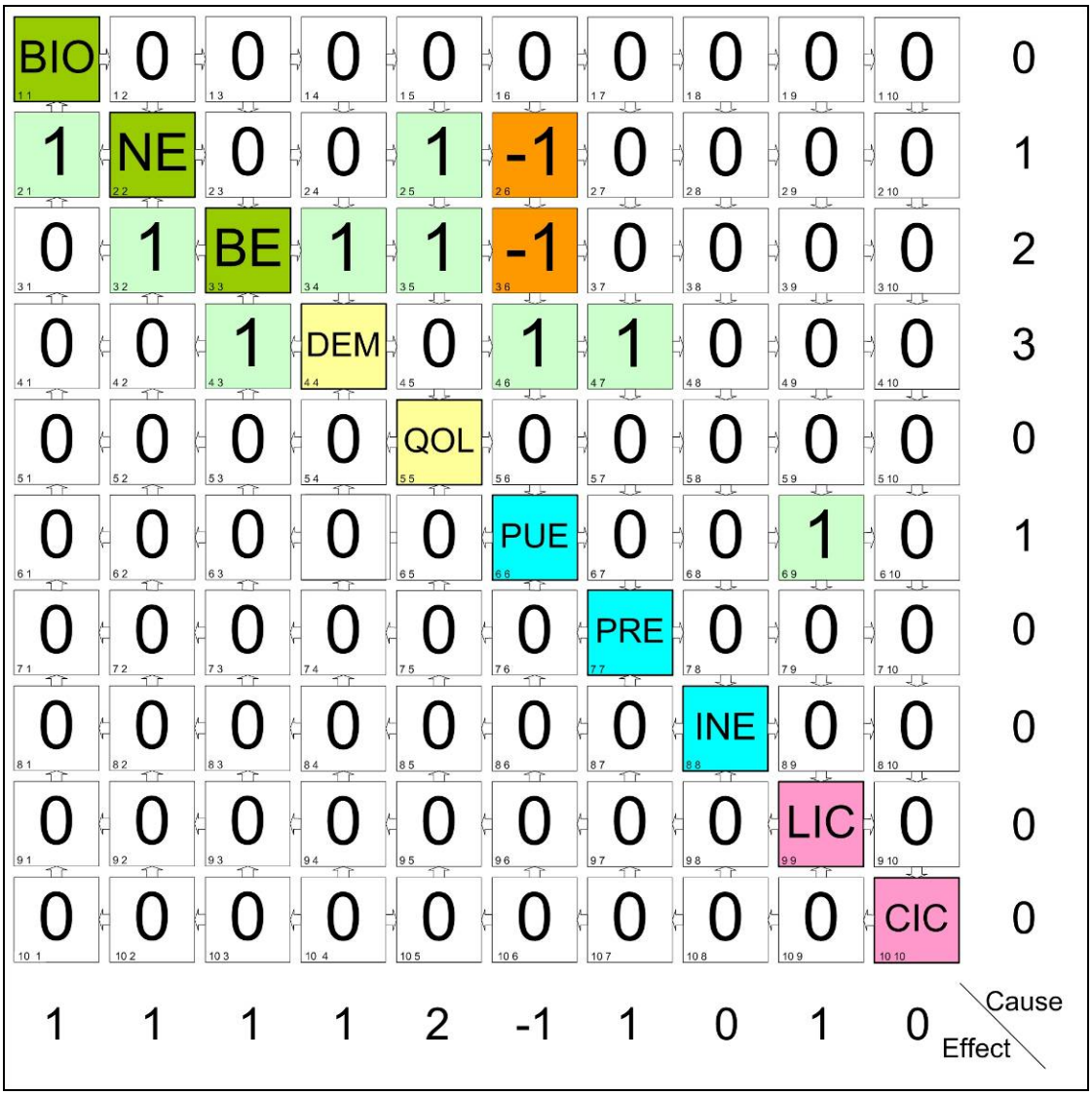


Figure 91: The expert-semi quantitative coded site specific matrix for the redevelopment of the Basford Gasworks site for housing

In summary, redevelopment for industrial and commercial units is the most appropriate redevelopment option for the Basford Gasworks site as it is the only one, of the three assessed, that met the redevelopment objectives.

9.5 Summary

In this chapter, Brownfield REMIT/RESPONSE has been used to develop a generic brownfield redevelopment matrix that has been used as the basis to assess the impact of different redevelopment options. This matrix was used to assess the appropriateness of redevelopment options at different sites and has been used to determine which redevelopment option is most suitable at the Basford Gasworks site.

Chapter 10: Discussion

The principal question addressed within this thesis is: How can an appropriate redevelopment option for an urban brownfield site be determined? Chapter 10 tackles this question by discussing the results of the National Garden Festivals evaluation (chapter 5), applying urban simulation to select redevelopment options (chapter 6) and the application of Brownfield REMIT/RESPONSE to the Radford Site (chapter 8), Shaw and Marvin Site, Willoughby Garages Site and Basford Gasworks (Chapter 9), drawing out the lessons learned from each.

10.1 Event Based Regeneration: Past, Present and Future

The analysis of the National Garden Festivals (Chapter 5) showed that the policy was most successful in Stoke-on-Trent as this was the only festival site that has been fully redeveloped as a direct result of the garden festival. The Liverpool and Glasgow sites have been partially redeveloped but in both cases further public expenditure has been required and both still have areas that have yet to be redeveloped 23 and 19 years respectively after the National Garden Festival closed its gates.

The garden festivals are an example of how policy can alter the process of brownfield redevelopment as additional stages for planning, implementing and hosting the festival were necessary to achieve the objectives of the policy (Figure 92). These additional stages were justified because the sites were unlikely to have been redeveloped without policy intervention.

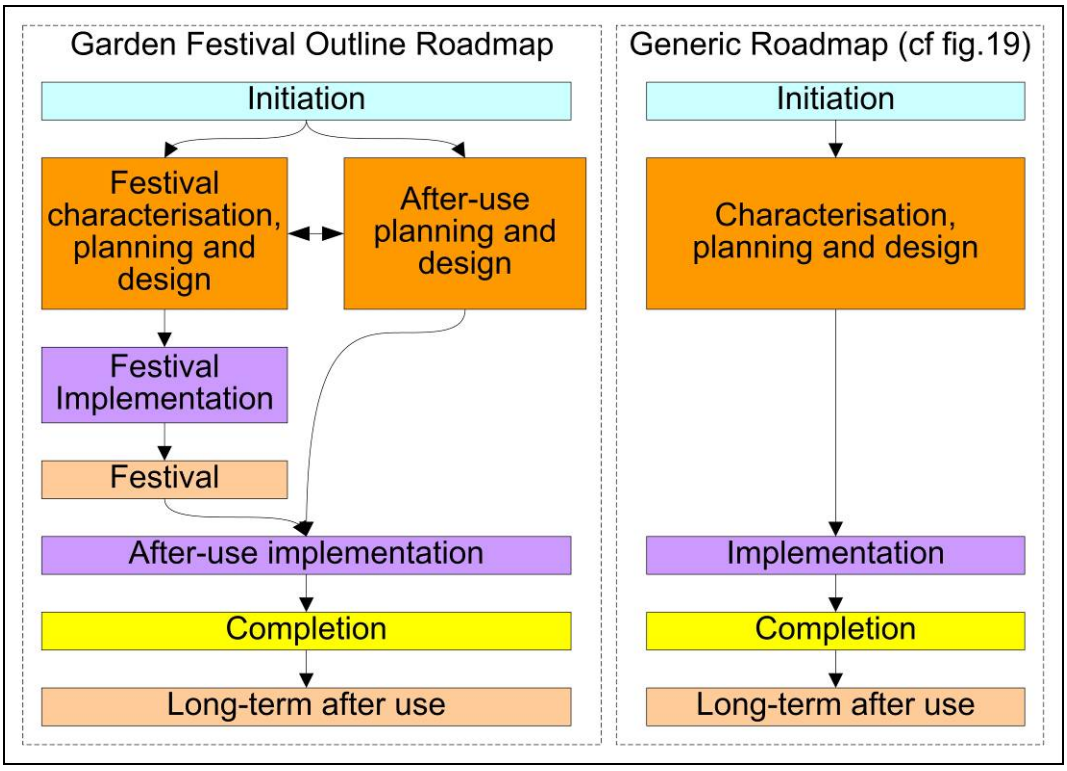


Figure 92: Comparison between the National Garden Festival redevelopment process and the redevelopment roadmap

The original concept for the initiative was to use public money, the funds of the Merseyside Development Corporation in Liverpool, the Derelict Land Grant at Stoke and the funds of the Scottish Development Agency (which later merged with the Scottish Training Agency to form Scottish Enterprise) at Glasgow, to reclaim a large derelict site to host a festival of attractions for six months and then the improved site sold for redevelopment (Heseltine, 2000; Theokas, 2004). However, of the three festivals analysed only Stoke matched this concept. In Liverpool, following the success of the festival it was re-opened on a smaller scale for two additional summers which delayed the sale of the main area of the festival for redevelopment and it was not until 1992 that redevelopment for an after use was completed (although the site has since become derelict again). In Glasgow, the process of redevelopment fits the model but the time scale was protracted and much of the site remained vacant for over ten years. The National Garden Festivals were considered to be an experiment (Smith Morris, 1997) and perhaps the most damming piece of evidence regarding their

success was discontinuation which was achieved simply by not awarding a festival for 1994 (Theokas, 2004).

A number of lessons can be drawn from the garden festivals. Firstly, a one off investment in reclaiming and remediating a brownfield site does not lead to long-term re-use unless it is linked to plans for a long-term after use. In both Glasgow and Liverpool the reclamation and remediation of the site did not lead to the redevelopment of the site after the festival, but in Stoke it did. This illustrates that applying the same policy under different circumstances can have different influences on the redevelopment of brownfield sites and suggests that redevelopment policies should be tailored to the needs of a specific place rather than applied generically regardless of the circumstances.

Secondly brownfield redevelopment will only contribute to urban regeneration if it helps to tackle underlying problems. In Liverpool, the underlying problem of unemployment has not been solved and Liverpool Riverside ward still has the third highest rate of unemployment in the UK despite the redevelopment that has taken place on parts of the garden festival site (Beale and Townsend, 2006). Perhaps if the original proposals to redevelop the land to provide new economic infrastructure had been achieved this would be very different.

The UK has a tradition of redeveloping derelict sites to host temporary events that dates back over half a century. In 1951, the same year as the first ever garden festival took place in Hanover, the main exhibition of the Festival of Britain was built on derelict land on the south bank of the Thames in London (Gardiner, 1999; Festival of Britain Society, 2006). Following this, the idea lay dormant, in the UK at least, until the National Garden Festivals. More recent examples are the Millennium Exhibition at the Greenwich Peninsula in London and the City of Manchester Stadium built for

2002 Commonwealth Games. The London Olympics in 2012 will continue this tradition as the Olympic Park is being built on a site with substantial areas of derelict, vacant and underused land in East London's Lower Lea Valley (Olympic Delivery Authority, 2007). The key lesson to be drawn from the evaluation of the garden festivals is the importance of identifying a redevelopment option for the site and developing a plan to implement this. This is further supported by the City of Manchester Stadium which had an after use plan that linked the temporary use of the site for the Commonwealth Games with a long-term after use - the stadium was modified and handed over to Manchester City Football Club (Thornley, 2002; Gratton et al., 2005). Therefore, if the London 2012 Olympic Games is to repeat the success of The National Garden Festival Stoke '86 and the City of Manchester stadium it is vital that appropriate after uses are identified and plans developed to link the temporary use of sites for Olympic Games with these after-uses.

10.2 An Urban Simulation Approach to Selecting Brownfield Redevelopment Options

The evaluation of urban simulation found that it was not possible to forecast the impact of brownfield redevelopment on the surrounding urban area using the available models. Neither SimCity 4 nor UrbanSim 3 was found to meet the required criteria to carry out the desired analysis. In SimCity 4 it was possible for buildings to become vacant and if the buildings remained vacant they could become derelict. However, the process of a derelict building returning to a beneficial-use does not satisfactorily represent the behaviour of brownfield redevelopment (see section 6.3.1). In UrbanSim, it was found that it is neither possible to classify land as brownfield sites nor does the development model simulate the creation of brownfield sites (see section 6.3.2). In conclusion, neither model simulates the redevelopment of brownfield sites

satisfactorily and therefore cannot be used as part of the process of selecting an appropriate redevelopment option for a brownfield site.

There are a number of factors that explain why these results were so. Currently urban models focus primarily on simulating the dynamics of urban growth and neglect the dynamics of urban change and decay, often because it is more difficult to model these dynamics. Even UrbanSim that was developed to address the limitations of existing models has a bias towards greenfield development. SimCity is ultimately a game and the models in it exaggerate the effects of the player's actions as the aim is to provide a good game and not to provide a realistic simulation of a city. Therefore it is unsurprising that it does not provide a realistic model of the brownfield redevelopment process.

10.3 A Systems Approach to Selecting Brownfield Redevelopment Options

Brownfield regeneration involves the integration of the processes of town planning, urban regeneration, environmental risk management, project management, construction and a number of other processes dependant on the characteristics of the site, the area and the project. To successfully meet its overall objectives a brownfield redevelopment project must satisfy the objectives of each of these individual processes using the tools associated with them. Brownfield REMIT/RESPONSE provides an integrated tool that combines the individual findings or outputs of these tools and allows the project to be assessed as a whole rather than in a piecemeal fashion – i.e. it provides a tool that can be used to consider brownfield redevelopment in an integrated manner with the surrounding urban area. It does not replace, for example, the need to assess the environmental impact of redevelopment, instead it provides a method to consider the results of such an assessment within the context of

the project as a whole and within the context of the surrounding urban area. This provides a method to balance the social, economic and environment aspects of redevelopment in a joined up manner that is conducive to achieving sustainable brownfield regeneration, i.e. returning brownfield sites to use in environmentally non-degrading, economically viable and socially acceptable ways (RESCUE, 2005).

Brownfield REMIT/RESPONSE has a number of advantages:

It can be applied to consider brownfield redevelopment holistically within a wider framework;

It does not require the same level of knowledge about each aspect of the brownfield redevelopment system;

It can be used to compare alternative redevelopment options, and;

It is adaptable in terms of scale and complexity.

Brownfield REMIT/RESPONSE allows the redevelopment of a site to be considered holistically as it allows the relationship between components to be considered both in their own right and within the context of the system as a whole.

Due to the matrix coding methods that are suggested for use within Brownfield REMIT/RESPONSE it is possible to incorporate different levels of knowledge about interactions within the same matrix which ensures that it makes use of all the available information.

Once the site specific matrix has been generated it can be used to compare alternative options. This can be done by considering different redevelopment options in terms of the perturbations they will exert on the system and exploring the consequences of these perturbations.

The interaction matrix can contain any number of components depending on the project objectives and the level of analysis required and, in theory, there is no limit on

the number of components that can be used. Therefore it can be adapted to meet the required scale and complexity of any given application.

The method also has limitations:

There is no well articulated theory of urban areas to assist its application;

It relies heavily on the expertise of the person applying it, and;

There is no specific method for allocating the weightings for coding the matrix.

There is currently no well articulated theory of urban areas that can be relied upon to develop the atlas of mechanisms which describe the operation of the system and therefore the Brownfield REMIT/RESPONSE approach relies heavily on the expertise of the practitioner developing the generic matrix. The original REMIT/RESPONSE was developed, in part, to overcome the problem that the technical information about rock engineering that exists in textbooks and in the minds of experts is often not easily accessible in a coherent fashion to those engaged in construction (Yang and Zhang, 1997). Similarly information about the impact of brownfield redevelopment is not necessarily easily available to those managing or assessing redevelopment projects. Brownfield REMIT/RESPONSE could help to over come this problem by making the relevant aspects of urban theory available to brownfield redevelopment practitioners in the form of generic interaction matrices (Figure 69).

Brownfield REMIT/RESPONSE does not provide a specific method to allocate the weightings in the suggested coding method, the expert semi-quantified (ESQ) method. However, the reason for using the ESQ coding is that, in general, the relationships being dealt with in brownfield redevelopment are unquantifiable and in such situations Jiao and Hudson (1995) suggest that ESQ can be used to assign numbers to mechanism to indicate their significance in the context of the objectives. Another

reason for using the coding method suggested is that it is difficult to apply the more numerical coding methods to the relationships involved in brownfield redevelopment and the literature fails to provide any examples of the numeric coded applications of the R^2 approach even in its applications to rock engineering.

By including public consultation as part of the Brownfield REMIT/RESPONSE process, the objectives of different stakeholders can be considered within the assessment of brownfield redevelopment and ensures that the method is open to public scrutiny. To avoid subjectivity when applying the method, the information used in selecting redevelopment options can be presented in a generic interaction matrix which can be easily used, understood and, where necessary, modified by others. This allows an open dialogue between stakeholders and forces the impacts of development to be explored and defended rather than simply stated.

A recent report by The Royal Commission on Environmental Pollution (2007) concluded that the mismatch between complex problems and simplistic policy solutions is the principal cause of a lack of satisfactory progress in many areas of urban environmental policy. Brownfield REMIT/RESPONSE provides a tool to assess the impact of brownfield redevelopment projects within the context of urban areas as complex and interactive systems as it allows not only the impact of redevelopment to be considered but also how the urban system will respond to these impacts. Therefore, Brownfield REMIT/RESPONSE provides a means to develop urban land use policies for post-industrial urban areas that take into account the complexity of the problems being addressed.

A number of tools exist to assess the sustainability of brownfield redevelopment including a checklist on sustainable land recycling (Ferber and Grimski, 2002), the Sustainability Assessment Tool (RESCUE, 2004a; and 2005) and the redevelopment

assessment framework (K. Pediaditi et al., 2006) but Brownfield REMIT/RESPONSE differs from all of these in one major respect: rather than develop a set of indicators and then assess a project against them, Brownfield REMIT/RESPONSE develops a model based on the project and the objectives of the assessment or analysis being carried out. In this way Brownfield REMIT/RESPONSE provides a single framework for analysing the complex multi-issue process of brownfield redevelopment which could be applied to assess the sustainability of a redevelopment project.

The applications of Brownfield REMIT/RESPONSE within this thesis have focused on relatively small areas but it would be possible to include the impact of redevelopment on a larger area. However, modelling a wider area in the same detail as the site and its immediate surroundings may provide more detail than required. For example, if the application of Brownfield REMIT/RESPONSE to the Radford site was expanded to include an objective relating to the impact of the redevelopment on the rest of Nottingham it may not be necessary to consider how each of the 12 components affects the rest of Nottingham. A possible solution to this is to use a matrix that has sub-matrices with different resolutions (Figure 93). This allows the resolution of the matrix to be matched to the level of analysis required. In this example the resolution is highest for the redevelopment project and lowest for the rest of the world, i.e. the matrix gets coarser as you move away from the project representing its diminishing impact. Returning to the above example we could analyse the effects of, for example, the environmental, social and economic impacts of the redevelopment on the rest of Nottingham.

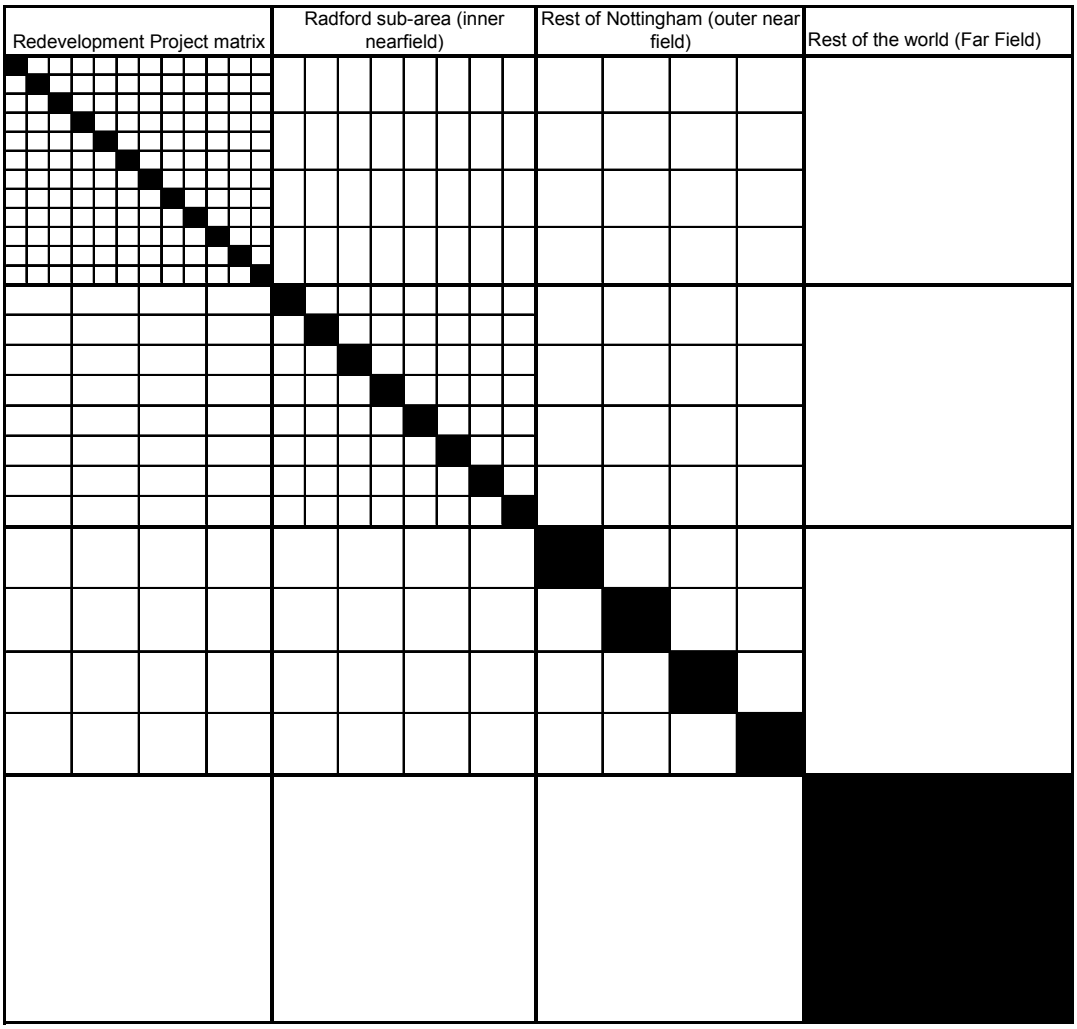


Figure 93: A matrix with mixed resolutions illustrating how different scales of analysis could be incorporated in a single matrix

Applying the Brownfield ReMIT/ReSPONSE method using mixed resolution matrices may also be an means to consider the

10.3.1 Methodological Difficulties in Applying REMIT/RESPONSE to Brownfield Redevelopment

Urban areas are recognised as being of major importance in the contemporary world and have been the subject of analysis for a number of decades (Burgess, 1925; Le Corbusier, 1947; Jacobs, 1962; Clark, 1996; Byrne, 2001; Boddy and Parkinson, 2004; Florida, 2005; HM Treasury et al., 2006; Hübner, 2006; Parkinson et al., 2006). Despite significant advances in understanding there is no adequately-articulated body of theory on urban areas (Wilson, 2000). Such a body of theory exists for rock

engineering and Hudson (1992) argues that it can be found in the main twenty-five or so text books and in the minds of experts. When this body of theory is applied within the framework of the interaction matrix it provides an *Atlas of Rock Engineering Mechanisms* for a given type of rock engineering problem or situation. Hudson, for example, applied this body of theory to develop atlases for slope stability and underground excavations in rock (Hudson, 1992).

The lack of an easily accessible body of urban theory presents an initial challenge to the application of REMIT/RESPONSE to urban areas in general and in particular to the identification, synthesis or development of an effective theory of urban areas that can be applied to the generation of an atlas of urban brownfield redevelopment and regeneration mechanisms. This has been described as one of the great scientific challenges of the 21st century (Wilson, 2000). In part, Wilson argues, this lack of a theoretical body is caused by the interdisciplinary nature of the study of urban areas and the fact that different perspectives have not been forced together. Hudson identifies the need for a list of all system properties and an understanding of all system mechanisms as a starting point for REMIT/RESPONSE. Although such a list has been developed as part of this thesis (see section 4.2.3, Table 7 and Table 8) an understanding of all system mechanisms does not exist for urban areas or for brownfield redevelopment. As such the third step in applying REMIT/RESPONSE is more difficult as the matrix must be populated in the absence of a comprehensive list of brownfield redevelopment mechanisms. This does not prevent REMIT/RESPONSE being applied to brownfield redevelopment but it does mean that the mechanisms operating at a brownfield site must be investigated each time the approach is applied until such a body of theory can be generated.

10.3.2 The Radford Site

To demonstrate that Brownfield REMIT/RESPONSE can be used to analyse and model brownfield redevelopment it was applied to the Radford site to determine the influence of policy on the redevelopment of the site. This application was retrospective and did not include the evaluation of alternative redevelopment options or the selection of a preferred option (see section 7.5.2).

Upon initial inspection the redevelopment process at the Radford site does not appear to follow the process as it is illustrated in the brownfield roadmap (Figure 94).

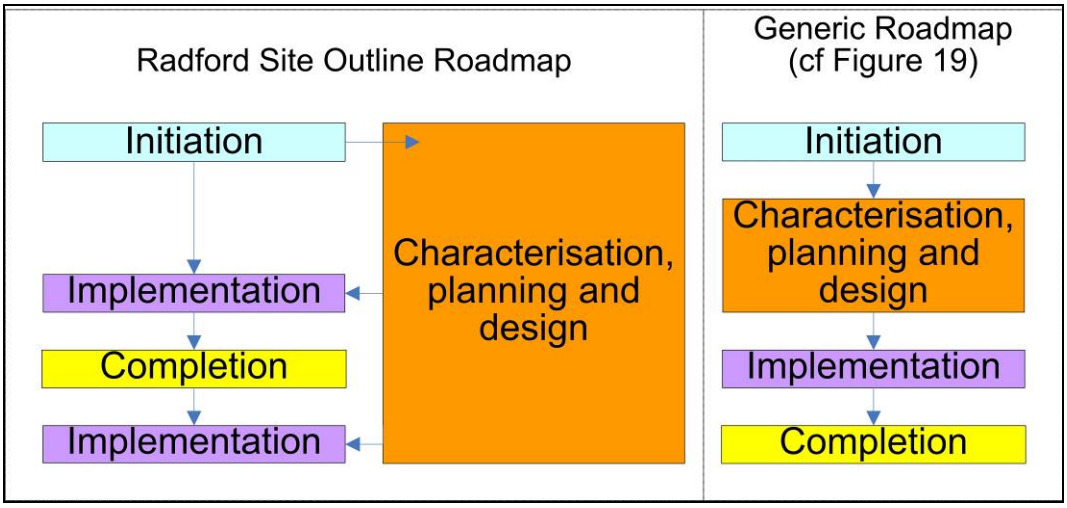


Figure 94: Comparison between the redevelopment process at the Radford site and the generic redevelopment roadmap

However, if the redevelopment of the Radford site is considered as the redevelopment of three separate brownfield sites (Chettle's Yard and Radford Goods Yard can be considered as one site here), the process does adhere to that identified in the roadmap (Figure 95). The Radford site illustrates that the stages are not always linear: implementation began at Chettle's Yard and Radford Goods Yard while the planning and design were still on going.

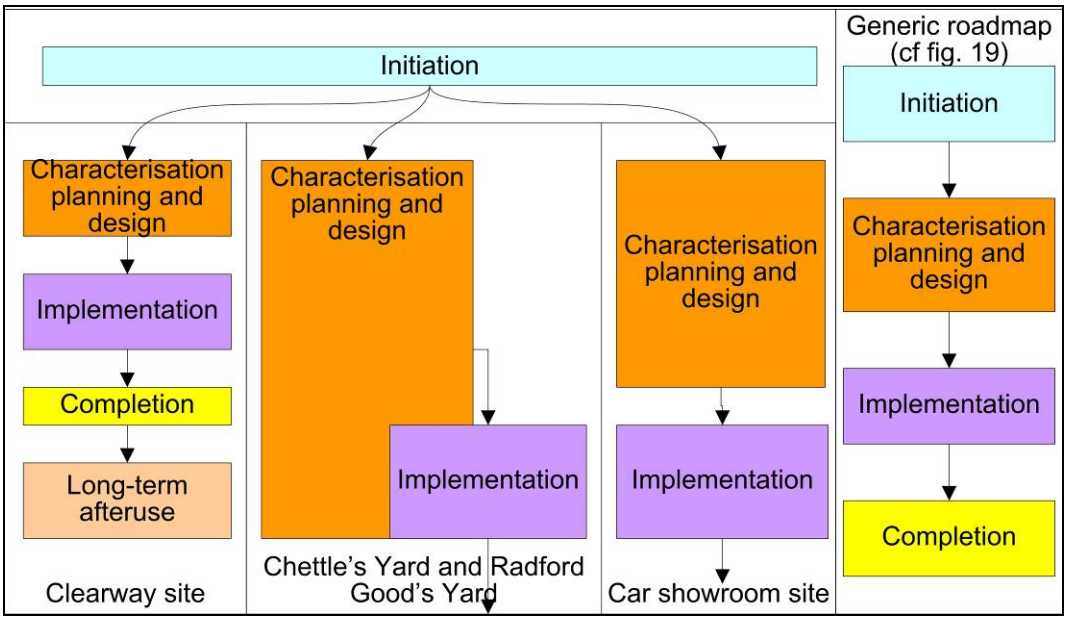


Figure 95: Modified roadmap of redevelopment process at the Radford site

The application of Brownfield REMIT/RESPONSE was successful and it was found that policy had influenced the redevelopment of the Radford site in a number of ways:

It initiated the redevelopment of the site;

Flexibility within local planning policy allowed reallocation of the site to make redevelopment viable;

It ensured that redevelopment contributes to the achievement of Nottingham City Council objectives and benefits the general public;

It has ensured that redevelopment will not be at unacceptable risk from flooding or cause additional flood risk elsewhere;

It has ensured that the first phase of the redevelopment does not prohibit the comprehensive redevelopment of the site;

The policy process has delayed redevelopment (development of the planning brief, development control and the negotiation of the S106 agreement) and include delays, those caused by the Environment Agency's objections to the development, that could have been avoided, and;

Planning policy ensured that site characterisation and assessment focused on environmental aspects and required no assessment of the social or economic impact of the redevelopment or its sustainability.

A number of implications for brownfield redevelopment in general can be drawn from the redevelopment of the Radford site and these will now be discussed. The Environment Agency did not raise their objection to the development when consulted on the draft development brief in February 2003 (Nottingham City Council, 2004c). If they had done so rather than waiting until the planning application was submitted the delays to the development control process could have been avoided. This is an example of how a lack of integration between different policy-making bodies can unnecessarily delay brownfield redevelopment. Such an occurrence is less likely to occur now as, from the 1st October 2006, the Environment Agency is a statutory consultee on flood risk: Local authorities must consult the Environment Agency when considering planning applications in areas of high flood risk and on all developments over one hectare wherever they are located to ensure that surface runoff will not cause flooding elsewhere. This should not however prevent the Environment Agency from engaging in the redevelopment process at an early stage to avoid a repeat of the delays experienced at Radford. To avoid such delays occurring in the Thames Gateway, where 85,000 new dwellings may be at risk from flooding (Brown, 2005), lessons must be learned from examples like the Radford site. Earlier engagement with the redevelopment process from the Environment Agency or consultation with the Environment Agency prior to carrying out the flood risk assessment to determine what requirements it had could have avoided these delays.

The need to compromise between different policy objectives was also identified during the application of Brownfield REMIT/RESPONSE at Radford. To fulfil the

City Council's objective to provide purpose built managed student accommodation on suitable sites the objective of ensuring that development does not create unbalanced communities will be compromised. Due to the site's location close to the University of Nottingham's Jubilee Campus and good transport links, it is considered to be suitable for purpose built student accommodation in order to prevent the further occupation of existing dwellings by student households. However, the proposed development will not meet the council's criteria for maintaining and creating balanced communities. This illustrates how, during redevelopment, it may not be possible to meet all of the relevant objectives and that compromises may have to be made in meeting policy goals. Brownfield REMIT/RESPONSE provides a means to assess the contribution of a redevelopment project to different objectives and using the interaction matrix combined with the ESQ matrix coding method it is possible to ensure that the best possible compromise is achieved when choosing between options.

The redevelopment of the Radford site also highlighted the consequences of not monitoring the impact of redevelopment (see chapter 5). The planning conditions for the development of the Clearway Distribution area prevent the student accommodation from being let to anyone keeping a car within the Nottingham area (Freeth Cartright, 2005). However, from site visits it is clear that a significant number of the students living in the new development were keeping a car in Nottingham. This situation has not been addressed and is symptomatic of the wider lack of monitoring of the impact of development. This lack of monitoring threatens to undermine the legitimacy of the planning process as the grounds on which planning decisions are made remain unverified. Brownfield REMIT/RESPONSE seeks to avoid suffering similar problems by the inclusion of the need to monitor the actual impact of development within its process. The results of such monitoring not only verify the

accuracy of the predicted impacts but can also be fed back into the generic matrix to ensure that it better represents the brownfield redevelopment system.

The application of Brownfield REMIT/RESPONSE to the Radford site identified a number of limitations of the interaction matrix as a means of representing the brownfield redevelopment system. The interaction matrix lacks a method to represent time and there is currently no method for dealing with interactions that happen at different times. For example both local planning policy and work to implement the development have a 'critical' interaction with land use but they do not affect land use in the same time frame. Local policy is critical in determining what the land use will be (i.e. at the planning stage) whereas work to implement the development is critical in terms of changing the land use of the site (i.e. at the implementation stage). The matrix presents all interactions taking place simultaneously which is not a reflection of the real world situation but a simplification required to model the system. One way to solve this problem is to investigate the time sequence of interactions using matrix pathway analysis (see p95-100 of Hudson, 1992).

Another limitation of the matrix is the problem of two components in combination affecting a single component. Consider the relationships between contamination, remediation and site characterisation. One approach to mapping the interaction is that the scale and nature of contamination determines what remediation work is required to ensure that the levels of risk are acceptable (component A affects component B directly). An alternative mapping would be that the remediation that must be carried out depends on the findings of the site characterisation which in turn depends on the scale and nature of contamination (component A influences component B indirectly via component C). Further more, although the relationships are represented as being the same, in reality they are not. Site investigation does not change the land quality

(assuming extra pathways are not created through poor practice) it only changes what we know whereas remediation actually changes the land quality. This is not reflected in the matrix. A single off-diagonal term may also represent multiple mechanisms. For example site investigation requires work to be carried out, effects what remediation work is carried out and also what geotechnical work needs to be carried out. All three of these and more are represented in a single off-diagonal term in the matrix.

10.3.3 The Generic Interaction Matrix and the Assessment of Brownfield Redevelopment Options Using Brownfield REMIT/RESPONSE

Brownfield redevelopment is a solution to blight caused by dereliction and it also offers opportunities for new development which can contribute to the regeneration of urban areas by tackling underlying problems. Such development can provide new jobs, new homes, new services and new open space within existing urban areas but brownfield redevelopment does not necessarily deliver regeneration. It is only likely to do so if an appropriate redevelopment option is chosen that reflects the needs of the surrounding urban area. Brownfield REMIT/RESPONSE provides a means to evaluate the consequences of redevelopment to determine if the stated regeneration objectives will be met. Brownfield REMIT/RESPONSE is built on the premise that it is not sufficient to assume that redevelopment will lead to regeneration and requires any stated benefits to be linked, through a chain of interactions, back to the redevelopment. Therefore, it provides a means to test the assumptions associated with any regeneration effects as it is necessary to provide evidence of how and why they are likely to occur.

The generic brownfield redevelopment matrix was developed from a review of urban theory and the lessons learnt from applying Brownfield REMIT/RESPONSE to the

Radford site to show how the different components of the brownfield redevelopment system interact. It provides the basis to analyse how the system will respond to different perturbations caused by brownfield redevelopment.

10.3.4 The Shaw and Marvin Site and the Willoughby Garages Site

The Shaw and Marvin site and the Willoughby Garages site projects were simple applications of Brownfield REMIT/RESPONSE using the generic brownfield interaction matrix to identify the direct impacts and secondary responsess of redevelopment to determine if a pre-selected redevelopment option was appropriate.

In both cases, the matrix was used predictively as the redevelopment process was still in the characterisation, planning and design stage and it was following the redevelopment process as outlined in the brownfield roadmap (Figure 96).

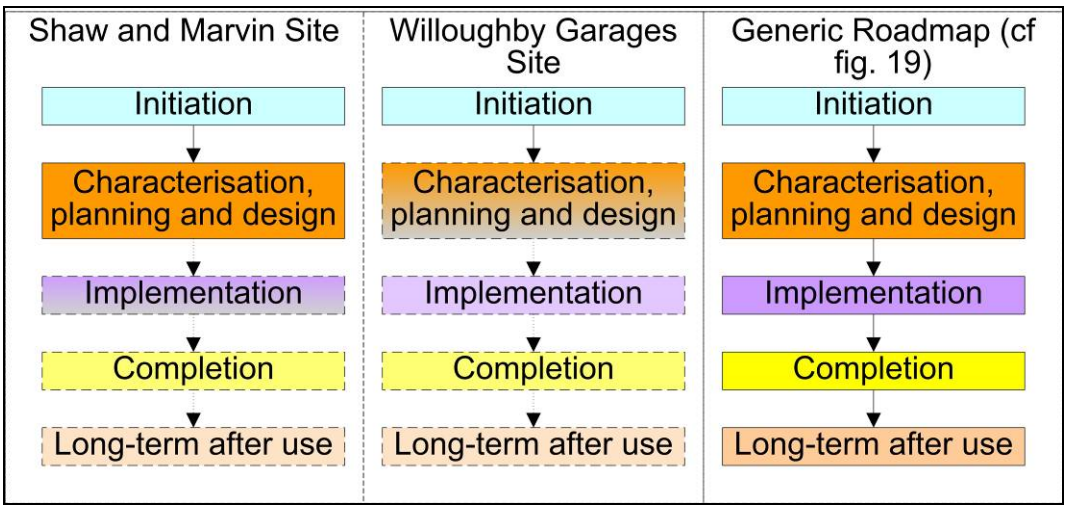


Figure 96: Comparison between the redevelopment process at the Shaw and Marvin, and Willoughby Garages Sites and the redevelopment roadmap

By introducing redevelopment as a perturbation within the generic brownfield redevelopment matrix it was possible to assess how the system would respond to these changes and identify the impact of redevelopment. At the Shaw and Marvin site the impact of redevelopment was found to be generally positive with a number of minor negative impacts and it was concluded that the chosen redevelopment option was appropriate. At the Willoughby Garages site the impact of redevelopment was found

to be generally insignificant and it was concluded that whilst the redevelopment was not inappropriate it is likely that a more beneficial redevelopment option could be identified. This could be done by carrying out a detailed analysis using Brownfield REMIT/RESPONSE to identify the most appropriate of a range of alternative redevelopment options.

10.3.5 Basford Gasworks

The Basford Gasworks application of the generic brownfield redevelopment matrix included more detailed investigation of the systemic impacts of redevelopment. The redevelopment process at Basford Gasworks differs from the redevelopment process as described in the brownfield roadmap as remediation was carried out prior to the commencement of the redevelopment project (Figure 97). Therefore, there were additional stages for the characterisation, planning, design and implementation of the remediation work prior to characterisation, planning and design for an after-use.

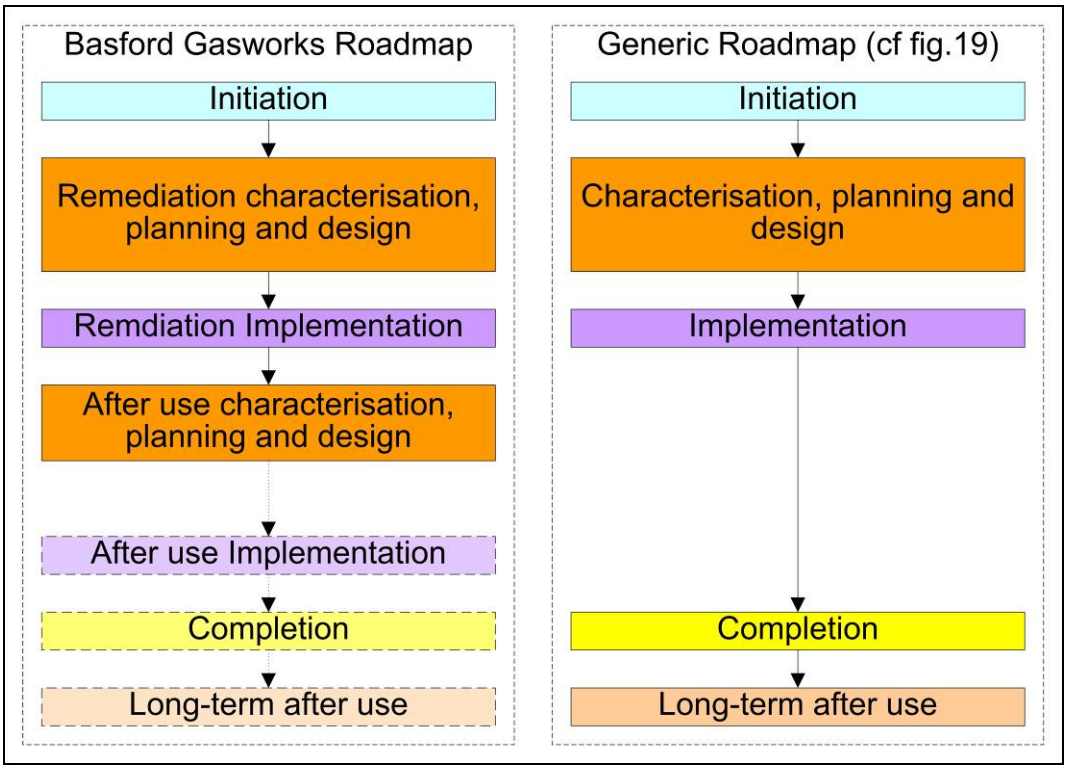


Figure 97: Comparison between the redevelopment process at the Basford Gasworks Site and the redevelopment roadmap

The application of Brownfield REMIT/RESPONSE differed from the previous applications in that once the direct impacts and secondary responses of redevelopment had been identified, further research was carried out to explore any systemic impacts that were likely to be caused. In the case of redevelopment for a food superstore, the direct impact of increased traffic was linked to systemic effects including adverse health effects, the creation of 'fresh food deserts' and increased carbon dioxide emissions. Similarly, in both the case of redevelopment for a food supermarket and for industrial and commercial units, increased household income was linked to the systemic impacts of rising rents and property values, upgrading of homes, out-migration and rising vacancy rates. By considering an urban area as a system made up of interconnected components it was possible to identify indirect impacts of redevelopment. This demonstrated the need to consider brownfield redevelopment within the context of the urban area and to consider how the urban system may respond to redevelopment.

By comparing and assessing the impact of each of the redevelopment options against the redevelopment and regeneration objectives using Brownfield REMIT/RESPONSE it was possible to identify that industrial and commercial units were the most appropriate redevelopment option for the Basford Gasworks site. This application demonstrated that Brownfield REMIT/RESPONSE provides a novel and original method to select an appropriate redevelopment option for a brownfield site.

10.4 The revised Brownfield REMIT/RESPONSE methodology

Having demonstrated that Brownfield REMIT/RESPONSE can be applied to assess how appropriate a redevelopment options is for a site, and having applied it, the methodology can be now be finalised so that it can be applied by others to assess

brownfield redevelopment options. The steps involved in assessing brownfield redevelopment options are shown in Figure 98.

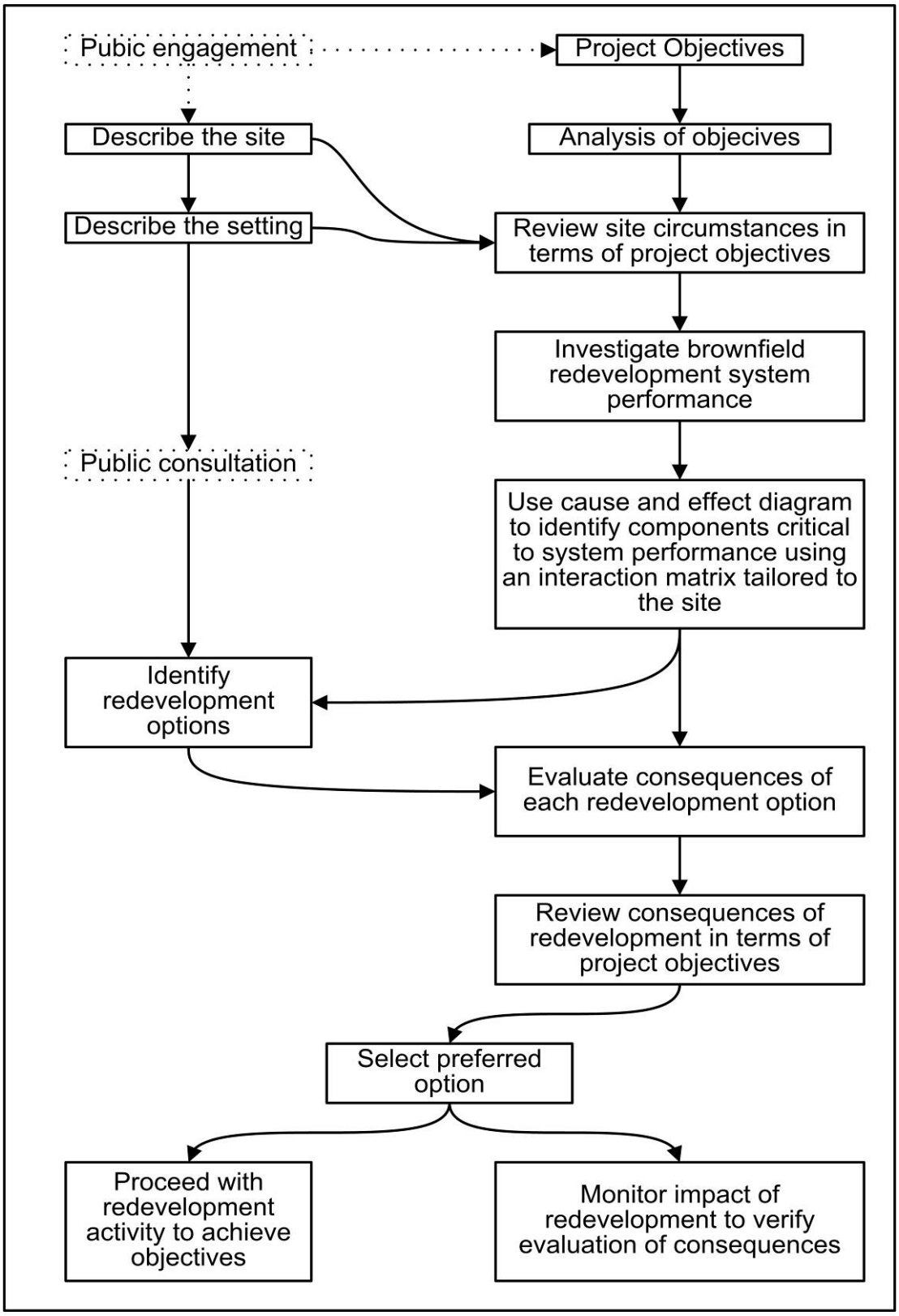


Figure 98: The Brownfield REMIT/RESPONSE systems approach to selecting an appropriate redevelopment option for a brownfield site

The steps of the method are as follows:

1. “Project Objectives” and “Analysis of Objectives”: Establish the redevelopment and regeneration objectives of the project;
2. “Describe the site” and “Describe the Setting”: Describe the site and the surrounding urban area to gain an understanding of the redevelopment. At this stage develop a roadmap of the redevelopment process to develop an understanding of the system.
3. “Review site circumstances in terms of the project objectives” to identify the leading components of the system formed by the site, the redevelopment project and the surrounding urban area
4. “Investigate brownfield redevelopment system performance” to produce a generic interaction matrix that describes how each component interacts with every other component. This will produce a generic matrix, or atlas of mechanisms, which describes the generic operation of the system but has not yet been tailored to the specific site. Code the matrix using the binary method to identify which mechanisms are present and to allow analysis of the system (see 7.3.5). The output of this is a binary coded generic matrix that describes which mechanisms within the generic system are active.
5. “Use cause and effect diagram to identify components critical to system performance using an interaction matrix tailored to the site” by investigating each of the identified mechanisms within the context of the project. Code the matrix using the expert semi-quantitative method (see Figure 47) to allow the strength of the relationships to be considered. The outcome of this step is a site-

specific coded interaction matrix that describes how the system operates at the specific site being investigated.

6. "Identify redevelopment options" using the knowledge of the system and in consultation with the various stakeholders of the project.
7. "Evaluate consequences of each redevelopment option" and "review consequences in terms of project objectives" by introducing redevelopment options to the system as a perturbation and assess the impact that each option has on the system can be assessed. This assessment can be carried out by applying an adapted version of the expert semi-quantitative method with a scale from -2 to +2, where -2 denotes a significant negative impact, -1 a minor negative impact, 0 no impact, +1 a minor positive impact and +2 a significant positive impact. Each redevelopment option identified as part of the Opportunity Plan should be introduced to the system as a perturbation and assessed in this way.
8. "Select preferred option" by comparing the impact of each redevelopment option to determine which option best meets the objectives without breaching the constraints. The option identified is the most appropriate redevelopment option for the site (N.B. this is not necessarily the most appropriate redevelopment option possible but is the most appropriate of the options compared).

Once the most appropriate redevelopment option for the site has been identified, the redevelopment process (see chapter 4) can continue.

Chapter 11: Conclusions and Further Work

The aim of the thesis is to develop a method for selecting an appropriate redevelopment option for a brownfield site.

The specific objectives are:

1. To determine if the National Garden Festivals can provide any lessons for delivering the most appropriate redevelopment option for brownfield sites over the long-term (Chapter 5);
2. To establish whether urban simulation can determine the most appropriate redevelopment options for a brownfield site (Chapter 6);
3. To develop a tool to assess the redevelopment of urban brownfield sites (Chapter 7);
4. To apply the developed tool to determine how policy can influence the redevelopment of a brownfield site (Chapter 8), and;
5. To apply the tool to assess and compare the redevelopment options of brownfield sites to select an appropriate redevelopment option for a site (Chapter 9)

11.1 Main Findings

Brownfield REMIT/RESPONSE (section 7.5) is a novel approach to the systematic analysis and modelling of brownfield redevelopment that can be applied to select an appropriate redevelopment option for a brownfield site. It provides a powerful tool to examine how brownfield redevelopment will impact urban areas by combining the Opportunity Plan (see chapter 1), which allows a series of potential redevelopment options to be identified by considering a site within its context, with the

REMIT/RESPONSE methodology (section 7.3), which can analyse how a system responds to changes. The tool allows policy makers, developers and other stakeholders to evaluate the direct impact of brownfield redevelopment on urban areas and also the consequences of changes to the urban system caused by brownfield redevelopment as part of the options appraisal process (section 4.3.2). Brownfield REMIT/RESPONSE allows the evaluation of the impact of redevelopment options to move beyond a reliance on theoretical benefits or benefits identified by a simple analysis of a project. It allows the impacts to be considered in a more sophisticated way that considers how the urban system will respond to change within the specific context of the site and project being assessed (section 7.3.5). Therefore, it provides a forensic tool to assess the impact of a particular redevelopment option in specific location. Within the context of urban regeneration policy in England, which includes delivering regeneration through brownfield redevelopment (see 3.2.3, 3.2.4 and 3.2.5), Brownfield REMIT/RESPONSE provides a method to consider how different redevelopment options will contribute to urban regeneration.

Brownfield REMIT/RESPONSE (cf Chapter 7, sections 10.3 and 10.4) provides a tool to assess the redevelopment options of brownfield sites in an integrated and systematic manner that considers the social, economic and environmental aspects of redevelopment. The method provides a means of explicitly stating the objectives of redevelopment (sections 7.3.2 and 7.5.3) and then analysing the system formed by the site, redevelopment and wider environment to explore the consequences of perturbations to the systemitended to meet these objectives (section 7.5.3). Brownfield REMIT/RESPONSE was used to develop a generic brownfield redevelopment matrix which could then be tailored to a particular site and used to assess redevelopment options for that site (section 9.1). The redevelopment options for three sites have been

assessed in this thesis (sections 9.2.4, 9.3.4 and 9.4.5). In the first two cases, Brownfield REMIT/RESPONSE and the generic matrix were used to assess the impact of a pre-selected redevelopment option to determine if it was appropriate. In the first case, the Shaw and Marvin site (section 9.2), it was shown that the redevelopment option was appropriate. In the second case, the Willoughby Garages site (section 9.3), it was shown that whilst the redevelopment option was not inappropriate, it was likely that a more beneficial option could be identified. In the third case, the Basford Gasworks site (section 9.4), **using Brownfield REMIT/RESPONSE it was possible to assess and compare the direct impacts, secondary responses and systemic responses of three redevelopment options to determine which of the three was most appropriate for the site (section 9.4.5).** Therefore, this research suggests that Brownfield REMIT/RESPONSE can provide the basis to select the most appropriate redevelopment option for a brownfield sites. However, the method can only compare alternative options to determine which is more appropriate; it does not provide an optimisation process to ensure that the option chosen is the most appropriate option possible.

Brownfield REMIT/RESPONSE also provides tools to help identify options that are likely to meet the project objectives. The site specific interaction matrix (section 7.3.5) can be used to identify perturbations that are likely to meet the project's objectives and allows potential redevelopment options to be identified through an analysis of how the urban system operates. The C,E diagram (section 7.3.5) shows which components are most interactive within the system and the dominance of each component and can be used to identify the likely scale of impact if different components are changed through redevelopment. For example, if a component is identified as being very interactive then redevelopment that will change the

component is likely to have considerable impact on the system. Alternatively if the objectives for the project relate to a component that is subordinate (i.e. the system has a greater impact on it that it has on the system) it may be necessary to consider an option that will achieve the objective indirectly (i.e. make a change to another component that will then impact the component of interest).

Through the development of generic interaction matrices (sections 7.5.3, 8.5.4 and 9.1), Brownfield REMIT/RESPONSE can be used to make relevant urban theory available to brownfield practitioners in an easily accessible format. Once produced these generic matrices can be tailored to form a site specific matrix that can be used to analyse redevelopment options at a specific site based on the most appropriate information available, either theoretically where site specific information is not available or empirical where there is knowledge available about the operation of the specific urban area being analysed. This should help to ensure that decisions about the redevelopment options for brownfield sites are made on the basis of the best available information.

Brownfield REMIT/RESPONSE was applied to the Radford site to determine how policy can influence the redevelopment of a brownfield site (Chapter 8). By analysing the system formed by the brownfield site, the surrounding area, policy and the redevelopment project (section 8.4.5) it was possible to identify the critical influences of policy on other components within the system (Figure 67). Detailed analysis identified two significant negative impacts of policy on the redevelopment process (section 8.5). Firstly, **there was no policy requirement for site characterisation and assessment at the Radford site to include an assessment of the sustainability of the redevelopment (section 8.5.5).** The focus of the impact assessment and information provided to Nottingham City Council as part of the development control

process has been on environmental impact. There appears to have been little need to provide social or economic impact assessments in order to satisfy the council's requirement for information to determine the impact of the development. Sustainable development requires the balancing of social, economic and environmental impacts of development (English Partnerships, 2003) but if, as in Nottingham, there is no formal requirement to assess the economic or social impact of brownfield redevelopment the delivery of sustainable development could be undermined. Secondly, **conflicts between the objectives of different policies or the policies of different bodies can delay the redevelopment of brownfield sites (section 8.5.4).** At the Radford site a conflict between the Nottingham City Council's policy to redevelop the site and the Environment Agency's policy on flood risk delayed redevelopment of the site for almost a year. This delay could have been avoided if the objectives of the Environment Agency had been established through pre-application consultations or if the Environment Agency had raised it objections to the redevelopment at the first opportunity.

The evaluation of the National Garden Festivals found that the policy had mixed results in terms of long-term redevelopment (section 5.2.3, 5.3.3 and 5.4.3) and it was concluded that redeveloping a site for a short-term time-limited event can be a successful strategy to stimulate the long-term redevelopment of a site but this is not always the case (sections 5.5.1 and 10.1). **The most important factor in delivering an appropriate redevelopment option where a site is initially redeveloped for a temporary event is the planning component of the characterisation, planning and design stage of the brownfield redevelopment process (sections 5.5.1 and 10.1).** The evaluation of the garden festivals suggests that a one-off investment in tackling the environmental problems of a site is not sufficient to deliver an appropriate

redevelopment option or return a site to beneficial use for the long-term. To return a site to a beneficial use for the long-term consideration of post-festival redevelopment was necessary during the planning stages for the short-term event (section 5.5.1). If, as in the Liverpool and Glasgow festivals, this is does not occur (section 5.2.1 and 5.4.1), then the site is unlikely to find a long-term after-use. Long-term use of a site will not follow the event unless sufficient measures are put in place to ensure that there is a mechanism by which the redevelopment will proceed once the short-term event has finished (section 5.5.1). A second key lesson from the evaluation was the need for flexibility within the planning process to allow for changing circumstances to be taken into consideration (section 5.5.1). Other lessons learned from the festivals was the importance of including long-term redevelopment as one of the objectives of the short-term event, the need to incorporate the benefits associated with the short-term event into a long-term strategy to maximise their impact and the need to integrate short-term projects with other policies that are ongoing (section 5.5.1). In order to deliver long-term redevelopment of brownfield sites through one-off time-limited events sufficient emphasis must be placed on planning what happens to the site once the event has finished (section 10.1). It is important to the long-term legacy of the London 2012 Olympic sites that such considerations are made during the preparations for the games (section 11.2).

The reviewed urban models could not be used to determine the most appropriate redevelopment option for a brownfield site (cf Chapter 6 and section 10.2). The review identified that neither SimCity 4 nor UrbanSim 3 model the dynamics of brownfield creation and redevelopment in such a way as to meet the criteria required (section 6.2, 6.3.1 and 6.3.2). The evaluation identified that UrbanSim 3 focuses on simulating the dynamics of urban growth rather than urban decay or the

redevelopment of brownfield sites (section 6.4 and 10.2) and as a result does not accurately represent post-industrial urban land management (section 10.2). SimCity 4 does include a representation of brownfield redevelopment but does not provide output data in a form that could be used to compare redevelopment options. Therefore, the models assessed were not able to forecast and compare the impact of brownfield redevelopment options on the surrounding urban area and could not be used as a means for identifying the most appropriate redevelopment option for a site.

11.2 Suggestions for Further Work

11.2.1 Analysis of regional and local policy impacts on redevelopment rates

An issue that has arisen while carrying out this research is whether differences in regional and local rates of brownfield redevelopment can be attributed to different policies at the local and regional levels or whether they are due to other factors (section 3.5). To investigate this, analysis could be carried out to determine the factors that influence the regional and local rates of brownfield redevelopment and greenfield consumption and to establish the influence of local and regional policy on them.

11.2.2 Develop an Urban Model That Could be Used to Forecast the Impact of Brownfield Redevelopment

Since, the review of urban models (chapter 6) was carried out a new version of UrbanSim (section 6.1) has been released which includes an updated development model (UrbanSim, 2007a). An idea for future research is to assess whether this new version meets the criteria set out in this thesis and could therefore be used as part of an analysis to determine the most appropriate redevelopment option for a brownfield site. However, if the updated UrbanSim does not meet the criteria, a new model could be

developed to forecasting the impact of brownfield redevelopment. One of the advantages of UrbanSim is that it is modular and new models can be added to the central modelling framework, therefore it may be possible to develop a component for UrbanSim that represented the effects of brownfield redevelopment on the surrounding urban area. Such a component is considered by one of the developers as being of wide interest to the users of UrbanSim (Waddell, 2005). Alternatively a model could be developed from scratch that simulates the dynamics of urban change and decline.

11.2.3 Explore the application of Brownfield REMIT/RESPONSE to design brownfield site investigations and to identify barriers to redevelopment

Within this research, Brownfield REMIT/RESPONSE has been applied both retrospectively to assess the impact of policy on redevelopment (chapter 8) and predicatively to assess the impact of redevelopment on the surrounding urban area (chapter 9). The tool may also have a number of other applications related to brownfield redevelopment. Brownfield REMIT/RESPONSE could be used to help design site investigation and characterisation. By performing the information audit associated with the ReMIT stage of the method (see section 7.3.4 and Nathanail, 2005) it would be possible to identify what information was required. This could then guide the site investigation and ensure that only relevant information was collected.

Proposed changes to the Government policy include the introduction of local brownfield action plans that would identify barriers to redevelopment and how they can be overcome (ODPM, 2005c). During the application of Brownfield REMIT/RESPONSE at the Radford site the barriers to redevelopment were identified (sections 8.4 and 8.5) and therefore it may be able to assist in the development of

brownfield action plans. To test if this is the case it would be necessary to apply it to other sites to determine if it identified the barriers at these sites.

11.2.4 Asses the Sustainability of the Redevelopment Option Chosen for the Radford Site

The research identified that at the Radford site there was no requirement to analyse the social and economic impact of the site (section 8.5.5 and 10.3.1) and therefore the delivery of sustainable redevelopment may be undermined. However, if the redevelopment of the site is sustainable despite this not being carried out then enforcing a requirement to do so is likely to delay and increase the cost of redevelopment. Therefore an application of Brownfield REMIT/RESPONSE with objectives derived from the definition of sustainable regeneration (RESCUE, 2005) could be carried out to determine if the redevelopment of the site is sustainable.

11.2.5 Develop a Range of Generic Brownfield Redevelopment Matrices

One of the potential barriers to the wide spread use of Brownfield REMIT/RESPONSE is the lack of a coherent body of urban theory (section 7.4.1). To overcome this, generic brownfield redevelopment matrices could be developed for a range of different situations. Hudson (1992) developed such atlases for two rock engineering situations: rock slopes and underground excavations in rock. In this research a single generic brownfield redevelopment matrix was developed but atlases could be developed for a number brownfield redevelopment situations. Atlases could be developed based on combinations of past and proposed land (e.g. former factory proposed for redevelopment for housing) in a variety of settings (e.g. town centre, urban rural fringe, residential neighbours, isolated site).

If such atlases were available to brownfield project managers, they could provide an initial source of information regarding the operation of the process they were managing and provide a staring point for assessing the redevelopment options.

11.2.6 Apply Brownfield REMIT/RESPONSE to the London 2012 Olympics

The results from the analysis of the National Garden Festivals (chapter 5) and the lessons drawn from this about event-led redevelopment (section 10.1) could be combined with Brownfield REMIT/RESPONSE (section 7.5) to investigate the potential impact of future event-led redevelopment. An analysis of brownfield redevelopment associated with the 2012 Olympic Games in London could be carried out to determine appropriate redevelopment options for the sites temporarily used as part of the games. The results of such an analysis could be fed into the planning process of the games to ensure that the public expenditure leads to long-term benefits in terms of regeneration. Ensuring that appropriate long-term uses are identified could help connect the short term benefits that will be delivered by London hosting the games with the regeneration of this area of London. By planning the short term hosting of the games in conjunction with the long-term regeneration of the surrounding area, the Olympic Delivery Authority London could look to repeat the success of Stoke garden festival and the city of Manchester stadium rather than repeat the failings of Liverpool garden festival.

11.3 Summary

This thesis has developed several new and improved approaches for assessing brownfield redevelopment as part of urban regeneration:

1. Proposed new measures to monitor the success of brownfield redevelopment policy (Chapter 3);
2. The assessment of past brownfield regeneration policy to determine the long term impact (Chapter 5 and Leney et al. 2005)
3. The use of a systematic approach to assess the impact of policy on the redevelopment of a brownfield site (chapter 8);
4. The use of cause and effect diagrams to identify the interactivity and dominance of components within a brownfield redevelopment system (Chapter 8 and 9);
5. The development of generic brownfield redevelopment interaction matrices to make relevant urban theory available to brownfield practitioners in an easily accessible format (Chapter 8 and 9);
6. The use of interaction matrices to determine secondary and systemic impacts of brownfield redevelopment on the surrounding area (Chapter 9);
7. The selection of an appropriate redevelopment option for a brownfield site through a systematic analysis of the impacts of redevelopment on the surrounding urban area chapter 9).

In conclusion, brownfield ReMIT/ReSPONSE is the integration of the opportunity plan, which allows a brownfield process manager to identify a series of potential redevelopment options by considering a site within its context, with the REMIT/RESPONSE methodology, which can be used to analyse the impact of redevelopment on the surrounding urban area. This forms a novel approach to the systematic analysis and modelling of brownfield redevelopment and the selection of an appropriate redevelopment option for a brownfield site (Figure 98).

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Appendices

Appendix A – Justifications for the matrix coding at the Radford site

Cell	Binary score	ESQ Score	Justification
1,1	n/a	n/a	Leading component – General site characteristics
1,2	1	1	As the site was fairly small, the size of the site had only a weak impact on the variety of subsurface conditions
1,3	1	2	The size of the site had some effect on the variety of contamination found across the different zones but did not result in much variation with the main source of contamination being hydrocarbons in the made ground
1,4	1	3	The existing community has a strong influence on the social mix as it determines the baseline conditions for social mix post-redevelopment. This is not critical because the population introduced by redevelopment will be greater than the existing community
1,5	1	2	Although the area was reasonably well suited for family housing the lack of access to secondary schools and dominance of the need for student accommodation meant this did not had only a limited influence on housing stock
1,6	1	3	Low demand for land for employment generating land uses has reduced the potential number of jobs provided on the site.
1,7	1	3	The location of the site close to the Jubilee campus of the university of Nottingham had a strong influence on local policy as the site was identified within housing strategy as being suitable for purpose built student accommodation.
1,8	1	1	The site had no specific allocations (such as listed buildings or being a local nature reserve) that had any great impact on development control although there were some minor considerations due to its location
1,9	0	0	The location of the site meant there were no specific area based funds available so this mechanism was not active
1,10	1	3	The feasibilities carried out for emda and Nottingham City Council identified that industrial land uses alone where not feasible for the site and that housing development was feasible
1,11	1	3	As the site is above 1ha an Environmental Impact Assessment was required. As the redevelopment of site is being delivered in a phased manner, investigations are being carried out in a piecemeal fashion rather than for the site as a whole.
1,12	1	4	As the different zones of the site are in the ownership of different parties the work to implement the development

			has been duplicated, particularly during the characterisation, planning and design stage of redevelopment.
2,1	1	2	The path of the River Leen creates the boundary to the east of the site in the North and central areas of the site and the need to allow access to the Leen slightly reduced the developable area of the site.
2,2	n/a	n/a	Leading component – Natural environment
2,3	1	3	The presence of in-filled channels created preferential pathways for contamination, creating potential pathways from the site to the River Leen.
2,4	0	0	No mechanism identified in generic interaction matrix
2,5	0	0	No mechanism identified in generic interaction matrix
2,6	0	0	No mechanism identified in generic interaction matrix
2,7	1	2	The River Leen corridor and the biodiversity that exists within had some influence on local policy as did the potential for biodiversity in other areas of the site
2,8	1	1	The low biodiversity value of the site meant that development control was only weakly by influenced by the natural environment (the issue of flood risk was introduced by the Environment Agency to the development control process not directly by the presence of the River Leen)
2,9	1	4	The location of the site in the flood plain of the River Leen triggered the involvement of the Environment Agency in the redevelopment process
2,10	1	1	The presence of the River Leen and the need to allow access to it had a limited impact on the land use of the site
2,11	1	3	The presence of the River Leen meant that flood risk and risk of increased flooding elsewhere had to be investigated.
2,12	1	2	The unstable nature of the made ground means that some work had to be carried out to improve the subsurface conditions to ensure that the building would not be at risk
3,1	0	0	Neighbouring users were not at risk from the contamination on the site so this mechanism is not active
3,2	1	1	The natural environment was not considered to be at any great risk from the contamination on site
3,3	n/a	n/a	Leading component – Land quality
3,4	0	0	The site was not highly contaminated so this mechanism is not active
3,5	0	0	The site was not highly contaminated so this mechanism is not active
3,6	0	0	No mechanism identified in generic interaction matrix
3,7	1	2	The former uses of the site and the potential contamination

			arising from them lead to the inclusion of policies in the Nottingham Local Plan and the development brief that contamination should be considered as part of the redevelopment of former industrial sites
3,8	1	2	The presence of methane generating material in the made ground and the areas of hydrocarbon contamination lead to the inclusion of development conditions to address these matters as part of redevelopment (e.g. gas monitoring and the installation of a passive venting trench)
3,9	0	0	The level of contamination did not lead to the site being designated as contaminated land by the Local authority so this mechanism is not active
3,10	1	3	Residential development on the site has been limited (or is proposed to be limited) to flats to avoid the need to remediate to a standard acceptable for houses with gardens
3,11	1	3	The presence of contamination has required phase I and II investigations for each set zone of the site that has had detailed planning proposals
3,12	1	3	Areas of contamination had to be remediated and this formed a significant part of the implementation work that has taken place to date.
4,1	1	1	The social mix arising from redevelopment may lead to some studentification of the wider area but as the development is largely self-contained the impact of this is likely to be limited.
4,2	0	0	No mechanism identified in generic interaction matrix
4,3	0	0	No mechanism identified in generic interaction matrix
4,4	n/a	n/a	Leading component – Social mix
4,5	1	2	Increases in the number of students in the area have led to some dwellings being converted to houses of multiple occupation reducing the number of dwellings available that are suitable for families
4,6	0	0	Although the social mix will be altered the demand for jobs among the existing community will remain unchanged therefore this mechanism is not active.
4,7	1	2	The relatively low level of students in the social mix of Radford (compared to the neighbouring area of Lenton) lead to the promotion of purpose built student accommodation in Radford to prevent further unbalancing of the community in other areas.
4,8	1	1	The effect of the redevelopment on social mix was given very little weight in considering the development proposals compared to other factors such as the need to redevelopment derelict land and provide student housing so social mix had only a weak influence on development control

4,9	0	0	The development will not a create balanced community so this mechanism is not active
4,10	1	3	The need for housing arising from a growing student population had a strong influence of the land use proposals for the site but this has been balanced by the need to provide jobs for the existing community and has resulted in proposals for a mixed use development
4,11	0	0	No investigations were carried out to determine the impact of development on community balance so this mechanism is not active
4,12	0	0	No mechanism identified in generic interaction matrix
5,1	1	1	The area surrounding the site already consists of a mixture of uses therefore the housing stock introduced will not significantly alter the nature (industrial, residential, mixed use area) of the surrounding area
5,2	0	0	No mechanism identified in generic interaction matrix
5,3	0	0	The adjacent housing stock is not a receptor for contamination so this mechanism is not active
5,4	1	4	The dominance of housing stock provision for a single demographic (students) is critical in determining the social mix of the area
5,5	n/a	n/a	Leading component – Housing stock
5,6	0	0	No mechanism identified in generic interaction matrix
5,7	1	2	The need to protect existing properties from conversion to student dwellings led to the allocation of part of the Radford site for student accommodation
5,8	0	0	No mechanism identified in generic interaction matrix
5,9	0	0	No mechanism identified in generic interaction matrix
5,10	1	1	A mismatch between housing stock and need has some influence over the redevelopment proposals but this was weak in comparison to other factors such as the political demand for purpose built student accommodation and the financial viability of such developments
5,11	0	0	Studies of housing stock were not carried out specifically as part of the redevelopment of the site so this mechanism is not active
5,12	0	0	No mechanism identified in generic interaction matrix
6,1	0	0	No mechanism identified in generic interaction matrix
6,2	0	0	No mechanism identified in generic interaction matrix
6,3	0	0	No mechanism identified in generic interaction matrix
6,4	0	0	The level of new jobs provided is unlikely to attract new people to move into the area so the mechanism is not active
6,5	0	0	No mechanism identified in generic interaction matrix
6,6	n/a	n/a	Leading component – jobs provided

6,7	1	2	The development brief states that the number of jobs provided on the redeveloped site should be at least as many as on the site prior to redevelopment, and therefore policy was influenced by the jobs provided on the site prior to redevelopment but this was only one of many factors that contributed to the local policy on the site
6,8	0	0	No mechanism identified in generic interaction matrix
6,9	0	0	No mechanism identified in generic interaction matrix
6,10	0	0	This mechanism was not active as it was delivered through planning policy not directly
6,11	0	0	No assessments were carried out to determine if the site was meeting its potential in terms of job provision so this mechanism was not active
6,12	0	0	No mechanism identified in generic interaction matrix
7,1	1	4	Local policy treats the four zones of the site as a single site and therefore effectively makes one larger site available for redevelopment
7,2	0	0	Local policy influenced the natural environment through development control rather than directly so this mechanism is not active
7,3	0	0	Local policy influenced land quality through development control rather than directly so this mechanism is not active
7,4	0	0	Local policy influenced social mix through development control rather than directly so this mechanism is not active
7,5	0	0	Local policy influenced housing stock through development control rather than directly so this mechanism is not active
7,6	0	0	Local policy influenced the jobs provided through development control rather than directly so this mechanism is not active
7,7	n/a	n/a	Leading component – Local policy
7,8	1	4	The Nottingham local plan sets the general framework against which decisions on redevelopment proposals will be judged including the need to provide employment generating uses and the Development Brief for the site sets more specific site based criteria against which proposals will be assessed
7,9	1	1	The policy to allowing housing on a previously developed site contributes very slightly to the achievement of the 60% target for new dwellings on PDL.
7,10	1	4	The Development Brief for the site and the Nottingham Local Plan dictate the land uses that will be acceptable at the site, including which uses will be considered acceptable at different zones of the site
7,11	1	3	The development brief for the site required any development proposals to include investigations

			demonstrating that the site can redeveloped without unacceptable health or safety risks to the users of the development or adjoining land
7,12	1	1	Remediation work in a small part of the site as part of the development of an adjoining development (Midland Court) had a very limited pump priming effect for the redevelopment of the site.
8,1	1	1	Conditions attached to planning permission have been included to prevent excessive on street parking but as there is little enforcement of this is having little impact
8,2	0	0	There was of limited nature conservation value so this mechanism is not active
8,3	0	0	This development control influenced land quality through work to implement the development rather than directly so this mechanism was not active
8,4	0	0	Development control did not ensure development contributed to a balanced community so this mechanism was not active.
8,5	0	0	No mechanism identified in generic interaction matrix
8,6	0	0	No mechanism identified in generic interaction matrix
8,7	1	3	Development control balanced the needs to provide student accommodation with the need to provide employment opportunities for local residents and ensured that the development was in general in accordance with local policies.
8,8	n/a	n/a	Leading component – Development control
8,9	1	1	Development control had only a weak influence on ensuring that flood risk was managed as the Environment Agency was not satisfied with the proposals and objected to the development
8,10	1	1	Planning permission did not significantly alter the land use of the development proposals
8,11	1	4	Conditions attached to the outline planning permission for the site and to the full planning permission of the Clearway zone required investigation of contamination and monitoring of ground gas levels
8,12	1	2	Planning conditions included the development of a spin road through the site, a walk way along the River Leen and highway works to create new access to the site, all of which added to the work that had to be done to implement the development
9,1	0	0	No mechanism identified in generic interaction matrix
9,2	0	0	No protected species were identified on site so this mechanism is not active
9,3	0	0	Other policy influence land quality through development control rather than directly so this mechanism was not

			active
9,4	1	3	The Sustainable Communities Plan strongly encourages the creation of balanced communities that reflect local circumstances so creates the framework for judging whether the community is balanced (in conjunction with local policy)
9,5	0	0	National planning policy influences housing stock through local policy rather than directly so this mechanism is not active
9,6	0	0	No mechanism identified in generic interaction matrix
9,7	1	3	The Nottingham Local Plan and the development brief for the site have been strongly influenced by national and regional planning policy, particularly PPG3 and the need to provide new dwellings on previously developed land
9,8	1	4	The Environment Agency objected to the outline proposals for the site which delayed a decision by 11 months and also had a knock on effect on the decision for the development of the Clearway zone
9,9	n/a	n/a	Leading component – Other policy
9,10	1	1	The promotion of the re-use of PDL for created an climate favourable towards housing at the Radford site but other local factors were more significant
9,11	1	3	The threshold for the need for Environmental Impact Assessment on any Urban development project exceeding 0.5 ha in size is set by The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999
9,12	1	2	The Environment Agency's objection to the flood risk assessment and the impact of the development lead to the need to develop surface water storage areas to cope with flood conditions that added to the work that had to be done to implement the development.
10,1	0	0	The integration of the site with the surrounding area is not a significant issues on the site due to the impermeable nature of the boundaries of the site so this mechanism is not active
10,2	1	3	The intense development of the site will lead to the sealing of much of the soil that is currently unsealed and the potential loss of habitat and biodiversity although the creation of areas of soft landscaping may create some new opportunities for biodiversity
10,3	0	0	Land use influences land quality through development control rather than directly so this mechanism is not active
10,4	0	0	Land use proposed will not ensure that development contributes to a balanced community so this mechanism was not active.
10,5	1	4	The land use proposals at the redevelopment will provide

			326 new student flats (housing up 1400 students), 64 two-bedroom apartments for the open market and flats providing 150 bed spaces for students or key workers
10,6	1	3	The proposal for employment generating land uses, primarily light industrial and warehousing with some office, will determining the number of jobs provided. The housing development will provide very few jobs. The proposed supermarket and café will also provide jobs
10,7	1	3	The proposed uses for the site (employment and generating uses) determine the sections of the Nottingham Local Plan that are relevant. Although the site is a mixed use development it is not treated as such within the Nottingham Local Plan. Instead it is considered to be an employment generating use with facilitating uses.
10,8	1	4	The proposals to develop the site for residential uses had a critical impact on the factors considered as part of development control (including remediation levels) and on the conditions attached to planning (such as monitoring of levels of gas in the ground and car parking allocations)
10,9	1	1	The mixture of uses determined which planning policy guidance notes / statements were relevant but this did not have a significant impact within the context of the system as a whole
10,10	n/a	n/a	Leading component – New land use
10,11	1	2	The significant change to the type of land use proposed by redevelopment had some influence on the need to carry out an Environmental Impact Assessment.
10,12	1	4	The variety and density of the land use proposed the redevelopment will require a large amount of work necessary to implement it
11,1	0	0	There was no impact into the impact of the development on the surrounding area so this mechanism is not active
11,2	1	2	Site investigations were carried out to identify the levels of biodiversity, flood risk and other characteristics of the natural environment. These did not alter the natural environment but they did effect what was known about them.
11,3	1	2	Site investigations were carried out to identify the levels of contamination and the risk associated with them. These did not alter the land quality they did effect what was known about it.
11,4	0	0	The council's method for determining whether a community is balanced was not applied to the development so this mechanism is not active
11,5	0	0	No investigation were carried out to assess gaps in the provision of housing stock so this mechanism is not active
11,6	1	1	The site investigation work may provide some jobs but

			this is a weak interaction as the number of jobs is likely to be limited in number and duration (and unlikely to provide jobs for local people).
11,7	1	3	Feasibility studies carried out by emda and Nottingham City Council lead to local policy being altered to reflect that the redevelopment of the site for employment generating uses alone was not economically viable, and enabling uses would be required to ensure that the employment generating uses would be delivered.
11,8	1	4	The characterisation of the site and of the development (including ecological value, flood risk, environment impact assessment, geotechnical and geo-environmental risk) was critical in making decisions on the proposed developments
11,9	1	4	The flood risk assessment was not considered sufficient by the Environment Agency which lead to it objecting to the development proposals for the site
11,10	1	2	Feasibility studies identified that industrial uses alone would not be a viable options for the site and that enabling uses would be required
11,11	n/a	n/a	Leading component – Site characterisation
11,12	1	4	A wide range of site assessments and the separate redevelopment of the different zones of the site contributed critically to the work done to implement the development
12,1	1	1	Implementation of redevelopment may result in some further subdivision of the site but this is not likely to have much significance
12,2	1	3	Geotechnical Work was carried out to ensure that the subsurface conditions were suitable for the proposed development
12,3	1	4	Remediation work has been critical in ensuring that the land quality of the site is suitable for the proposed uses
12,4	0	0	No mechanism identified in generic interaction matrix
12,5	0	0	No mechanism identified in generic interaction matrix
12,6	1	1	The construction work to implement the redevelopment may provide some jobs but this is a weak interaction as the number of jobs is likely to be limited in number and duration.
12,7	0	0	No work was carried out meet the requirements of local planning that was not required through planning conditions so this mechanism is not active.
12,8	1	4	The work carried out has been critical in ensuring that the conditions of planning permission have been met (for example gas monitoring and the installation of a passive venting trench at the Clearway zone)

12,9	1	2	The work to implement the site had some impact on other policy but this was not significant within the context of the system as a whole
12,10	1	4	Construction and other work has been critical in delivering the proposed land uses (where they have been delivered)
12,11	1	0	There is no evidence that unexpected conditions were discovered during implementation so this mechanism is not active
12,12	n/a	n/a	Leading component – Work to implement the redevelopment

Appendix B – Justifications for the matrix coding at the Shaw and Marvin site

Cell	Binary Score	ESQ Score	Justification
1,1	n/a	n/a	Leading component - Biodiversity
1,2	0	0	As there is no overall change to biodiversity there will be no impact of biodiversity on natural environment
1,3	0	0	No mechanism identified in generic interaction matrix
1,4	0	0	No mechanism identified in generic interaction matrix
1,5	1	0	Change in amount of biodiversity is unlikely to be significant enough to cause any change in quality of life
1,6	0	0	No mechanism identified in generic interaction matrix
1,7	0	0	No mechanism identified in generic interaction matrix
1,8	0	0	No mechanism identified in generic interaction matrix
1,9	0	0	Change in amount of biodiversity is unlikely to be significant enough to need any increase protection of biodiversity
1,10	0	0	Change in amount of biodiversity is unlikely to be significant enough to need any increase protection of biodiversity
2,1	1	+1	Habitat created by new trees may lead to some biodiversity on site
2,2	N/a	n/a	Leading component – Natural environment
2,3	1	0	There will be no change to the amount of open space caused by the redevelopment so the mechanism is not active
2,4	1	0	There will be no change to the amount of open space / greenfield land caused by the redevelopment so the mechanism is not active
2,5	1	0	As there is no creation of public open space and a decrease in the amount of habitat there is unlikely to be any impact on quality of life
2,6	1	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
2,7	1	0	No mechanism identified in generic interaction matrix
2,8	1	0	No mechanism identified in generic interaction matrix
2,9	1	0	As there will be no creation of habitat there will be no need for increased measures to protect habitats
2,10	1	0	As there will be no creation of habitat there will be no need for increased measures to protect habitats
3,1	1	-1	Sealing of soil and development on site will reduce the potential for biodiversity on site

3,2	1	-1	Development of site will destroy existing habit there is on site but new trees will provide some potential habitat
3,3	n/a	n/a	Leading component – Built environment
3,4	1	0	There will be no change in the number of dwellings therefore this mechanism is not active
3,5	1	+1	High quality built environment and removal of derelict buildings will tackle visual blight and contribute to improved quality of life
3,6	1	+1	The taking over of part of the public realm by a private company will reduce the maintenance costs for the council but this will not be of major significance due to the small area involved.
3,7	1	+2	4500m^2 of retail space will create ~240 jobs
3,8	1	+2	New retail space will change where people shop and therefore where they spend there money
3,9	1	0	There will be no creation of or impact to buildings of conservation value so the mechanism is not active
3,10	1	0	There will be no creation of or impact to buildings of conservation value so the mechanism is not active
4,1	0	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
4,2	1	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
4,3	0	0	There will be no change in home ownership levels caused by the redevelopment so the mechanism is not active
4,4	n/a	n/a	Leading component – Demographics
4,5	1	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
4,6	0	0	There will be no change of population caused by the redevelopment so the mechanism is not active
4,7	0	0	There will be no change of population caused by the redevelopment so the mechanism is not active
4,8	0	0	No mechanism identified in generic interaction matrix
4,9	0	0	No mechanism identified in generic interaction matrix
4,10	0	0	No mechanism identified in generic interaction matrix
5,1	0	0	No mechanism identified in generic interaction matrix
5,2	0	0	No mechanism identified in generic interaction matrix
5,3	0	0	There will be no change in crime or anti-social behaviour caused by the redevelopment so the mechanism is not active
5,4	0	0	Changes in quality of life are unlikely to be significant enough to affect population turnover rates
5,5	n/a	n/a	Leading component – Quality of Life
5,6	1	+1	Reduction in number of Job seekers allowance claimants

			would reduce amount paid in allowances.
5,7	0	0	There will be no change in amount of free time caused by the redevelopment so the mechanism is not active
5,8	0	0	There will be no change in level of education caused by the redevelopment so the mechanism is not active
5,9	0	0	There will be no change in level of deprivation caused by the redevelopment so the mechanism is not active
5,10	0	0	There will be no change in level of deprivation caused by the redevelopment so the mechanism is not active
6,1	0	0	There will be no change in public spending on open spaces caused by the redevelopment so the mechanism is not active
6,2	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,3	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,4	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,5	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,6	n/a	n/a	Leading component – Public economic
6,7	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,8	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,9	1	+2	Broxtowe Borough Council's budget could increase by 4.5% due to business rates from Tesco
6,10	1	+1	Increase in income tax and business rates will cause a minor increase in funds for central institutional controls
7,1	0	0	No mechanism identified in generic interaction matrix
7,2	1	-1	Increase in number of car journeys in central Beeston will have a negative impact on the natural environment (primarily air quality)
7,3	0	0	Redevelopment is unlikely to effect the success of business significantly enough to alter the upkeep of public or semi-public spaces so this mechanism is not active
7,4	1	+2	Unemployment in Broxtowe Borough could reduce by up to 240 (or by up to 25% based on Jan 2007 figures)
7,5	1	0	Provision of goods and services is likely to involve a relocation of provision not new provision so this mechanism is not active
7,6	1	+2	Broxtowe Borough Council would receive business rates from Tesco (up to £640,000 per year based on Tesco @ Toton)

7,7	n/a	n/a	Leading component – Private economic
7,8	1	+1	Creation of jobs will lead to employment for local people and therefore increased incomes
7,9	0	0	There will be no change in manufacturing caused by the redevelopment so the mechanism is not active
7,10	0	0	No mechanism identified in generic interaction matrix
8,1	0	0	No mechanism identified in generic interaction matrix
8,2	0	0	Changes in individual economic circumstances are unlikely to effect spending on private open space so this mechanism is not active
8,3	0	0	Changes in individual economic circumstances are unlikely to effect spending on upkeep of homes so this mechanism is not active
8,4	1	0	Changes in individual economic circumstances are unlikely to be significant enough to cause changes in socio-economic status
8,5	1	+1	Increase in quality of life for people who were unemployed who get jobs at the supermarket
8,6	1	+1	Slight increase in number of people paying income tax due to jobs created
8,7	1	+2	The new supermarket is likely to attract costumers to Beeston town centre and therefore increase the size of the convenience goods market in Beeston significantly
8,8	n/a	n/a	Leading component – Individual economic
8,9	0	0	No mechanism identified in generic interaction matrix
8,10	0	0	No mechanism identified in generic interaction matrix
9,1	0	0	There will be no change in level of protection of biodiversity caused by the redevelopment so the mechanism is not active
9,2	0	0	There will be no change in level of protection of the natural environment caused by the redevelopment so the mechanism is not active
9,3	0	0	There will be no change in level of protection of the buildings of historical or cultural value caused by the redevelopment so the mechanism is not active
9,4	0	0	No mechanism identified in generic interaction matrix
9,5	0	0	No mechanism identified in generic interaction matrix
9,6	0	0	There will be no change in level of public intervention or protection of the natural environment caused by the redevelopment so the mechanism is not active
9,7	0	0	No mechanism identified in generic interaction matrix
9,8	0	0	No mechanism identified in generic interaction matrix
9,9	n/a	n/a	Leading component – Local / regional institutional controls

9,10	0	0	No mechanism identified in generic interaction matrix
10,1	0	0	There will be no change in level of protection of biodiversity caused by the redevelopment so the mechanism is not active
10,2	0	0	There will be no change in level of protection of the natural environment caused by the redevelopment so the mechanism is not active
10,3	0	0	There will be no change in level of protection of the buildings of historical or cultural value caused by the redevelopment so the mechanism is not active
10,4	0	0	No mechanism identified in generic interaction matrix
10,5	0	0	No mechanism identified in generic interaction matrix
10,6	0	0	There will be no change in level of public intervention or protection of the natural environment caused by the redevelopment so the mechanism is not active
10,7	0	0	No mechanism identified in generic interaction matrix
10,8	0	0	No mechanism identified in generic interaction matrix
10,9	0	0	There will be no change in level of protection at the National / E.U. level caused by the redevelopment so the mechanism is not active
10,10	n/a	n/a	Leading component – Central / E.U. institutional controls

Appendix C – Justifications for the matrix coding at the Willoughby Garages site

Cell	Binary Score	ESQ Score	Justification
1,1	n/a	n/a	Leading component - Biodiversity
1,2	0	0	As there is overall change to biodiversity there will be no impact of biodiversity on natural environment
1,3	0	0	No mechanism identified in generic interaction matrix
1,4	0	0	No mechanism identified in generic interaction matrix
1,5	1	0	Change in amount of biodiversity is unlikely to be significant enough to cause any change in quality of life
1,6	0	0	No mechanism identified in generic interaction matrix
1,7	0	0	No mechanism identified in generic interaction matrix
1,8	0	0	No mechanism identified in generic interaction matrix
1,9	0	0	Change in amount of biodiversity is unlikely to be significant enough to need any increase protection of biodiversity
1,10	0	0	Change in amount of biodiversity is unlikely to be significant enough to need any increase protection of biodiversity
2,1	1	0	There will be no change to the amount of potential habitats caused by the redevelopment so the mechanism is not active
2,2	N/a	n/a	Leading component – Natural environment
2,3	1	0	There will be no change to the amount of open space caused by the redevelopment so the mechanism is not active
2,4	1	0	There will be no change to the amount of open space / greenfield land caused by the redevelopment so the mechanism is not active
2,5	1	0	As there is no creation of public open space and a decrease in the amount of habitat there is unlikely to be any impact on quality of life
2,6	1	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
2,7	1	0	No mechanism identified in generic interaction matrix
2,8	1	0	No mechanism identified in generic interaction matrix
2,9	1	0	As there will be no creation of habitat there will be no need for increased measures to protect habitats
2,10	1	0	As there will be no creation of habitat there will be no

			need for increased measures to protect habitats
3,1	1	0	There will be no change to the intensity of the use of the site as it is already fully developed in its current use so this mechanism is not active
3,2	1	0	There will be no change to the intensity of the use of the site as it is already fully developed in its current use so this mechanism is not active
3,3	n/a	n/a	Leading component – Built environment
3,4	1	0	There will be no change in the number of dwellings this mechanism is not active
3,5	1	0	There will be no change to the visual quality of the area due to redevelopment and the site is not currently derelict so this mechanism is not active
3,6	1	0	There will be no new public realm that requires maintenance so this mechanism is not active
3,7	1	+1	1000 sq m of retail and 400 sq m of retail will create up to 70 jobs (although Lidl operates with minimal staff so this may be less)
3,8	1	0	New retail space will change where people shop and therefore where they spend there money but it is unlikely to have any significant impact due to the size of the store
3,9	1	0	There will be no creation of or impact to buildings of conservation value so the mechanism is not active
3,10	1	0	There will be no creation of or impact to buildings of conservation value so the mechanism is not active
4,1	0	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
4,2	1	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
4,3	0	0	There will be no change in home ownership levels caused by the redevelopment so the mechanism is not active
4,4	n/a	n/a	Leading component – Demographics
4,5	1	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
4,6	0	0	There will be no change of population caused by the redevelopment so the mechanism is not active
4,7	0	0	There will be no change of population caused by the redevelopment so the mechanism is not active
4,8	0	0	No mechanism identified in generic interaction matrix
4,9	0	0	No mechanism identified in generic interaction matrix
4,10	0	0	No mechanism identified in generic interaction matrix
5,1	0	0	No mechanism identified in generic interaction matrix
5,2	0	0	No mechanism identified in generic interaction matrix
5,3	0	0	There will be no change in crime or anti-social behaviour

			caused by the redevelopment so the mechanism is not active
5,4	0	0	Changes in quality of life are unlikely to be significant enough to affect population turnover rates
5,5	n/a	n/a	Leading component – Quality of Life
5,6	1	+1	Reduction in number of Job seekers allowance claimants would reduce amount paid in allowances.
5,7	0	0	There will be no change in amount of free time caused by the redevelopment so the mechanism is not active
5,8	0	0	There will be no change in level of education caused by the redevelopment so the mechanism is not active
5,9	0	0	There will be no change in level of deprivation caused by the redevelopment so the mechanism is not active
5,10	0	0	There will be no change in level of deprivation caused by the redevelopment so the mechanism is not active
6,1	0	0	There will be no change in public spending on open spaces caused by the redevelopment so the mechanism is not active
6,2	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,3	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,4	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,5	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,6	n/a	n/a	Leading component – Public economic
6,7	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,8	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,9	1	+1	Broxtowe Borough Council's budget could increase by 0.5% due to business rates from Lidl
6,10	1	0	Increase in income tax and business rates will cause an insignificant increase in funds for central institutional controls
7,1	0	0	No mechanism identified in generic interaction matrix
7,2	1	-1	Increase in number of car journeys in central Beeston will have a negative impact on the natural environment (primarily air quality)
7,3	0	0	Redevelopment is unlikely to effect the success of business significantly enough to alter the upkeep of public or semi-public spaces so this mechanism is not active
7,4	1	1	Unemployment in Broxtowe Borough could reduce by up

			to 70 (or by up to 7% based on Jan 2007 figures)
7,5	1	0	Provision of goods and services is likely to involve a relocation of provision not new provision so this mechanism is not active
7,6	1	1	Broxtowe Borough Council would receive business rates from Tesco (up to £70000 per year based on Lidl @ West Point)
7,7	n/a	n/a	Leading component – Private economic
7,8	1	1	Creation of jobs will lead to employment for local people and therefore increased incomes
7,9	0	0	There will be no change in manufacturing caused by the redevelopment so the mechanism is not active
7,10	0	0	No mechanism identified in generic interaction matrix
8,1	0	0	No mechanism identified in generic interaction matrix
8,2	0	0	Changes in individual economic circumstances are unlikely to effect spending on private open space so this mechanism is not active
8,3	0	0	Changes in individual economic circumstances are unlikely to effect spending on upkeep of homes so this mechanism is not active
8,4	1	0	Changes in individual economic circumstances are unlikely to be significant enough to cause changes in socio-economic status
8,5	1	1	Increase in quality of life for people who were unemployed who get jobs at the supermarket
8,6	1	1	Slight increase in number of people paying income tax due to jobs created
8,7	1	0	The new supermarket is unlikely to attract significant numbers of new costumers to Beeston town centre and therefore will have little or no impact on the size of the convenience goods market in Beeston
8,8	n/a	n/a	Leading component – Individual economic
8,9	0	0	No mechanism identified in generic interaction matrix
8,10	0	0	No mechanism identified in generic interaction matrix
9,1	0	0	There will be no change in level of protection of biodiversity caused by the redevelopment so the mechanism is not active
9,2	0	0	There will be no change in level of protection of the natural environment caused by the redevelopment so the mechanism is not active
9,3	0	0	There will be no change in level of protection of the buildings of historical or cultural value caused by the redevelopment so the mechanism is not active
9,4	0	0	No mechanism identified in generic interaction matrix
9,5	0	0	No mechanism identified in generic interaction matrix

9,6	0	0	There will be no change in level of public intervention or protection of the natural environment caused by the redevelopment so the mechanism is not active
9,7	0	0	No mechanism identified in generic interaction matrix
9,8	0	0	No mechanism identified in generic interaction matrix
9,9	n/a	n/a	Leading component – Local / regional institutional controls
9,10	0	0	No mechanism identified in generic interaction matrix
10,1	0	0	There will be no change in level of protection of biodiversity caused by the redevelopment so the mechanism is not active
10,2	0	0	There will be no change in level of protection of the natural environment caused by the redevelopment so the mechanism is not active
10,3	0	0	There will be no change in level of protection of the buildings of historical or cultural value caused by the redevelopment so the mechanism is not active
10,4	0	0	No mechanism identified in generic interaction matrix
10,5	0	0	No mechanism identified in generic interaction matrix
10,6	0	0	There will be no change in level of public intervention or protection of the natural environment caused by the redevelopment so the mechanism is not active
10,7	0	0	No mechanism identified in generic interaction matrix
10,8	0	0	No mechanism identified in generic interaction matrix
10,9	0	0	There will be no change in level of protection at the National / E.U. level caused by the redevelopment so the mechanism is not active
10,10	n/a	n/a	Leading component – Central / E.U. institutional controls

Appendix D – Justifications for the matrix coding at the Basford Gasworks Site

Table D1: Industrial and commercial units

Cell	Binary Score	ESQ Score	Justification
1,1	n/a	n/a	Leading component - Biodiversity
1,2	0	0	Change in biodiversity is unlikely to be significant enough to cause any change to the natural environment
1,3	0	0	No mechanism identified in generic interaction matrix
1,4	0	0	No mechanism identified in generic interaction matrix
1,5	0	0	Change in biodiversity is unlikely to be significant enough to cause any change in quality of life
1,6	0	0	No mechanism identified in generic interaction matrix
1,7	0	0	No mechanism identified in generic interaction matrix
1,8	0	0	No mechanism identified in generic interaction matrix
1,9	0	0	Change in amount of biodiversity is unlikely to be significant enough to need any increase protection of biodiversity
1,10	0	0	Change in amount of biodiversity is unlikely to be significant enough to need any increase protection of biodiversity
2,1	1	+1	Minor increase in biodiversity likely due to habitats created by new park within the development and soft-landscaped areas
2,2	n/a	n/a	Leading component – Natural environment
2,3	0	0	The proportion of the site allocated for the park is not large enough to effect the intensity of the development therefore this mechanism is not active
2,4	0	0	The proportion of the site allocated for the park is not large enough to effect the population density of the development therefore this mechanism is not active
2,5	1	+1	The creation of new public open space in the form of a park is likely to have a minor impact of the quality of life for site users and those in adjacent areas as it will improve the provision of green public spaces in the area
2,6	1	-1	The need to maintain the new park will require public funds and therefore will have a minor negative impact on Nottingham City Council's budget
2,7	0	0	No mechanism identified in generic interaction matrix
2,8	0	0	No mechanism identified in generic interaction matrix
2,9	0	0	The habitats created through the development are unlikely to be significant enough to require increased measures to

			them so this mechanism is not active
2,10	0	0	The habitats created through the development are unlikely to be significant enough to require increased measures to them so this mechanism is not active
3,1	0	0	As the site is currently has little biodiversity this mechanism is not active
3,2	1	+1	The creation of the park will provide new habitats but due to the size of the park this will only have a minor impact
3,3	n/a	n/a	Leading component – Built environment
3,4	0	0	There will be no change in the number of dwellings therefore this mechanism is not active
3,5	1	+1	High quality built environment and removal of tackle visual blight caused by the derelict site will contribute to improved quality of life
3,6	1	-1	Improvements to the public realm and new access roads will require public funds for maintenance and therefore will have a minor negative impact on Nottingham City Council's budget
3,7	1	+2	The new industrial and commercial space will create around 350 jobs, which will be fairly well paid
3,8	0	0	No mechanism identified in generic interaction matrix
3,9	0	0	There will be no creation of or impact to buildings of conservation value so the mechanism is not active
3,10	0	0	There will be no creation of or impact to buildings of conservation value so the mechanism is not active
4,1	0	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
4,2	0	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
4,3	1	-1	Out migration may lead to increased number of vacant dwellings
4,4	n/a	n/a	Leading component – Demographics
4,5	0	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
4,6	0	0	There will be no change of population caused by the redevelopment so the mechanism is not active
4,7	0	0	There will be no change of population caused by the redevelopment so the mechanism is not active
4,8	0	0	No mechanism identified in generic interaction matrix
4,9	0	0	No mechanism identified in generic interaction matrix
4,10	0	0	No mechanism identified in generic interaction matrix
5,1	0	0	No mechanism identified in generic interaction matrix
5,2	0	0	No mechanism identified in generic interaction matrix
5,3	0	0	There will be no change in crime or anti-social behaviour

			caused by the redevelopment so the mechanism is not active
5,4	1	+1	Increased quality of life may lead to a decease in population turnover which would have a positive impact, although this is likely only to be minor
5,5	n/a	n/a	Leading component – Quality of Life
5,6	1	+2	Reduction in number of Job seekers allowance claimants would reduce amount paid in allowances.
5,7	0	0	There will be no change in amount of free time caused by the redevelopment so the mechanism is not active
5,8	0	0	There will be no change in level of education caused by the redevelopment so the mechanism is not active
5,9	1	+1	Creation of jobs and the associated reduction in unemployment will slightly reduce deprivation and require slightly less public intervention in the area
5,10	1	+1	Creation of jobs and the associated reduction in unemployment will slightly reduce deprivation and require slightly less public intervention in the area
6,1	0	0	No mechanism identified in generic interaction matrix
6,2	1	+1	Upkeep of the park and other soft landscaped features will contribute to the maintenance of the natural environment
6,3	0	0	There will be no change in public spending on the built environment caused by the redevelopment so the mechanism is not active
6,4	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,5	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,6	n/a	n/a	Leading component – Public economic
6,7	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,8	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,9	1	+1	There will be small increase in Nottingham City Council's budget due to the new business rates paid by companies operating out of the redeveloped site
6,10	0	0	Increase in income tax and business rates will cause an insignificant increase in funds for central institutional controls
7,1	0	0	No mechanism identified in generic interaction matrix
7,2	0	0	The increase in traffic will not be sufficient to cause increased air pollution so this mechanism is not active
7,3	1	+1	The new business will play a positive role in maintaining the built environment

7,4	1	+2	Unemployment in the Berrdige and Basford wards will be reduced by up to 350 (Base rate was 920 claiming unemployment benefits in January 2007)
7,5	0	0	Provision of goods and services is likely to involve a relocation of provision not new provision so this mechanism is not active
7,6	1	+1	Nottingham City Council would receive business rates from the business operating from the redeveloped site (up to £200,000 per year based on Genesis Park @ Radford – part of the Redevelopment of the Radford Site – see chapter 8)
7,7	n/a	n/a	Leading component – Private economic
7,8	1	+2	Provision of new, fairly well paid, jobs will have a major impact on the income of those who get the jobs
7,9	0	0	There will be no change in manufacturing caused by the redevelopment so the mechanism is not active
7,10	0	0	No mechanism identified in generic interaction matrix
8,1	0	0	No mechanism identified in generic interaction matrix
8,2	1	+1	Changes in income of local people getting jobs in the new development is likely to have a minor impact on spending on private open spaces such as gardens
8,3	1	+1	Changes in income of local people getting jobs in the new development is likely to have a minor impact on spending on maintenance and improvements of dwellings
8,4	1	-1	Increased incomes may lead to some people seeking to improve their home by moving out of the area to find a better one
8,5	1	+2	Increased incomes will have a significant impact on quality of life in the are, primarily for those who get jobs on the site
8,6	1	+1	Increased income will provide some additional income tax revenues
8,7	1	+2	Increased incomes will have a significant impact on levels of spending on goods and services, primarily by those who get jobs on the site
8,8	n/a	n/a	Leading component – Individual economic
8,9	0	0	No mechanism identified in generic interaction matrix
8,10	0	0	No mechanism identified in generic interaction matrix
9,1	0	0	There will be no change in level of protection of biodiversity caused by the redevelopment so the mechanism is not active
9,2	0	0	There will be no change in level of protection of the natural environment caused by the redevelopment so the mechanism is not active
9,3	0	0	There will be no change in level of protection of the

			buildings of historical or cultural value caused by the redevelopment so the mechanism is not active
9,4	0	0	No mechanism identified in generic interaction matrix
9,5	0	0	No mechanism identified in generic interaction matrix
9,6	0	0	There will be no change in level of public intervention or protection of the natural environment caused by the redevelopment so the mechanism is not active
9,7	0	0	No mechanism identified in generic interaction matrix
9,8	0	0	No mechanism identified in generic interaction matrix
9,9	n/a	n/a	Leading component – Local / regional institutional controls
9,10	0	0	No mechanism identified in generic interaction matrix
10,1	0	0	There will be no change in level of protection of biodiversity caused by the redevelopment so the mechanism is not active
10,2	0	0	There will be no change in level of protection of the natural environment caused by the redevelopment so the mechanism is not active
10,3	0	0	There will be no change in level of protection of the buildings of historical or cultural value caused by the redevelopment so the mechanism is not active
10,4	0	0	No mechanism identified in generic interaction matrix
10,5	0	0	No mechanism identified in generic interaction matrix
10,6	0	0	There will be no change in level of public intervention or protection of the natural environment caused by the redevelopment so the mechanism is not active
10,7	0	0	No mechanism identified in generic interaction matrix
10,8	0	0	No mechanism identified in generic interaction matrix
10,9	0	0	There will be no change in level of protection at the National / E.U. level caused by the redevelopment so the mechanism is not active
10,10	n/a	n/a	Leading component – Central / E.U. institutional controls

Table D2: Food retail superstore

Cell	Binary Score	ESQ Score	Justification
1,1	n/a	n/a	Leading component - Biodiversity
1,2	0	0	Change in biodiversity is unlikely to be significant enough to cause any change to the natural environment
1,3	0	0	No mechanism identified in generic interaction matrix
1,4	0	0	No mechanism identified in generic interaction matrix
1,5	0	0	Change in biodiversity is unlikely to be significant enough to cause any change in quality of life
1,6	0	0	No mechanism identified in generic interaction matrix
1,7	0	0	No mechanism identified in generic interaction matrix
1,8	0	0	No mechanism identified in generic interaction matrix
1,9	0	0	Change in amount of biodiversity is unlikely to be significant enough to need any increase protection of biodiversity
1,10	0	0	Change in amount of biodiversity is unlikely to be significant enough to need any increase protection of biodiversity
2,1	1	1	Minor increase in biodiversity likely due to habitats created by new park within the development and soft-landscaped areas
2,2	n/a	n/a	Leading component – Natural environment
2,3	0	0	The proportion of the site allocated for the park is not large enough to effect the intensity of the development therefore this mechanism is not active
2,4	0	0	The proportion of the site allocated for the park is not large enough to effect the population density of the development therefore this mechanism is not active
2,5	1	+1	The creation of new public open space in the form of a park is likely to have a minor impact of the quality of life for site users and those in adjacent areas as it will improve the provision of green public spaces in the area
2,6	1	-1	The need to maintain the new park will require public funds and therefore will have a minor negative impact on Nottingham City Council's budget
2,7	0	0	No mechanism identified in generic interaction matrix
2,8	0	0	No mechanism identified in generic interaction matrix
2,9	0	0	The habitats created through the development are unlikely to be significant enough to require increased measures to them so this mechanism is not active
2,10	0	0	The habitats created through the development are unlikely to be significant enough to require increased measures to them so this mechanism is not active
3,1	0	0	As the site is currently has little biodiversity this

			mechanism is not active
3,2	1	+1	The creation of the park will provide new habitats but due to the size of the park this will only have a minor impact
3,3	n/a	n/a	Leading component – Built environment
3,4	1	-2	Significant increase in traffic due to people driving to the new supermarket
3,5		+1	High quality built environment and removal of tackle visual blight caused by the derelict site will contribute to improved quality of life
3,6		-1	Improvements to the public realm and new access roads will require public funds for maintenance and therefore will have a minor negative impact on Nottingham City Council's budget
3,7		+2	New supermarket will create around 470 new jobs, although they will be low paid jobs.
3,8		0	No mechanism identified in generic interaction matrix
3,9		0	There will be no creation of or impact to buildings of conservation value so the mechanism is not active
3,10		0	There will be no creation of or impact to buildings of conservation value so the mechanism is not active
4,1		0	There will be no change of population density caused by the redevelopment so the mechanism is not active
4,2		-1	Increased traffic will have a detrimental effect on urban air quality and contribute to CO_2 emissions
4,3		-2	Increased traffic will cause increased congestion
4,4	n/a	n/a	Leading component – Demographics
4,5		-1	There will be a decrease in walking to local shops and possible adverse health effects due to the creation of fresh food deserts
4,6		0	There will be no change of population caused by the redevelopment so the mechanism is not active
4,7		-1	The new supermarket is likely to lead to the closure of some local shops both in the area around the site and possible in the Hyson Green shopping area
4,8		0	No mechanism identified in generic interaction matrix
4,9		0	No mechanism identified in generic interaction matrix
4,10		0	No mechanism identified in generic interaction matrix
5,1		0	No mechanism identified in generic interaction matrix
5,2		0	No mechanism identified in generic interaction matrix
5,3		-1	Possible vandalism at properties left vacant by closure of shops or out migration
5,4		+1	Increased quality of life may lead to a decease in population turnover which would have a positive impact, although this is likely only to be minor

5,5	n/a	n/a	Leading component – Quality of Life
5,6		+2	Reduction in number of Job seekers allowance claimants would reduce amount paid in allowances.
5,7		0	There will be no change in amount of free time caused by the redevelopment so the mechanism is not active
5,8		0	There will be no change in level of education caused by the redevelopment so the mechanism is not active
5,9		+1	Creation of jobs and the associated reduction in unemployment will slightly reduce deprivation and require slightly less public intervention in the area
5,10		+1	Creation of jobs and the associated reduction in unemployment will slightly reduce deprivation and require slightly less public intervention in the area
6,1		0	No mechanism identified in generic interaction matrix
6,2		+1	Upkeep of the park and other soft landscaped features will contribute to the maintenance of the natural environment
6,3		0	There will be no change in public spending on the built environment caused by the redevelopment so the mechanism is not active
6,4		0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,5		0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,6	n/a	n/a	Leading component – Public economic
6,7		0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,8		0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,9		+1	There will be small increase in Nottingham City Council's budget due to the new supermarket on the sites
6,10		0	Increase in income tax and business rates will cause an insignificant increase in funds for central institutional controls
7,1		0	No mechanism identified in generic interaction matrix
7,2		-1	Increase in number of car journeys will have a negative impact on the natural environment (primarily air quality)
7,3		-1	There will a negative impact associated with visual blight caused by vacant properties and the potential creation of brownfield sites if new uses are not found for the vacant properties
7,4		+2	Unemployment in the Berrdige and Basford wards will be reduced by up to 470 (Base rate was 920 claiming unemployment benefits in January 2007)
7,5		-1	Loss of amenity due to the closure of local shops and the

			potential for the creation of fresh food deserts, particularly for those without access to a car.
7,6		+1	Nottingham City Council would receive business rates from the supermarket (up to between £300,000 and £800,000 per year based on Sainsbury @: Castle Marina and Asda @ Hyson Green)
7,7	n/a	n/a	Leading component – Private economic
7,8		+1	Provision of new, fairly well paid, jobs will have a major impact on the income of those who get the jobs
7,9		0	There will be no change in manufacturing caused by the redevelopment so the mechanism is not active
7,10		0	No mechanism identified in generic interaction matrix
8,1		0	No mechanism identified in generic interaction matrix
8,2		+1	Changes in income of local people getting jobs in the new development is likely to have a minor impact on spending on private open spaces such as gardens
8,3		+1	Changes in income of local people getting jobs in the new development is likely to have a minor impact on spending on maintenance and improvements of dwellings
8,4		-1	Increased incomes may lead to some people seeking to improve their home by moving out of the area to find a better one
8,5		+1	Increased incomes will have some impact on quality of life in the are, primarily for those who get jobs on the site
8,6		+1	Increased income will provide some additional income tax revenues
8,7		+1	Increased incomes will have some impact on levels of spending on goods and services, primarily by those who get jobs on the site
8,8	n/a	n/a	Leading component – Individual economic
8,9		0	No mechanism identified in generic interaction matrix
8,10		0	No mechanism identified in generic interaction matrix
9,1		0	There will be no change in level of protection of biodiversity caused by the redevelopment so the mechanism is not active
9,2		0	There will be no change in level of protection of the natural environment caused by the redevelopment so the mechanism is not active
9,3		0	There will be no change in level of protection of the buildings of historical or cultural value caused by the redevelopment so the mechanism is not active
9,4		0	No mechanism identified in generic interaction matrix
9,5		0	No mechanism identified in generic interaction matrix
9,6		0	There will be no change in level of public intervention or protection of the natural environment caused by the

			redevelopment so the mechanism is not active
9,7		0	No mechanism identified in generic interaction matrix
9,8		0	No mechanism identified in generic interaction matrix
9,9	n/a	n/a	Leading component – Local / regional institutional controls
9,10		0	No mechanism identified in generic interaction matrix
10,1		0	There will be no change in level of protection of biodiversity caused by the redevelopment so the mechanism is not active
10,2		0	There will be no change in level of protection of the natural environment caused by the redevelopment so the mechanism is not active
10,3		0	There will be no change in level of protection of the buildings of historical or cultural value caused by the redevelopment so the mechanism is not active
10,4		0	No mechanism identified in generic interaction matrix
10,5		0	No mechanism identified in generic interaction matrix
10,6		0	There will be no change in level of public intervention or protection of the natural environment caused by the redevelopment so the mechanism is not active
10,7		0	No mechanism identified in generic interaction matrix
10,8		0	No mechanism identified in generic interaction matrix
10,9		0	There will be no change in level of protection at the National / E.U. level caused by the redevelopment so the mechanism is not active
10,10	n/a	n/a	Leading component – Central / E.U. institutional controls

Table D3: Family housing

Cell	Binary Score	ESQ Score	Justification
1,1	n/a	n/a	Leading component - Biodiversity
1,2	0	0	Change in biodiversity is unlikely to be significant enough to cause any change to the natural environment
1,3	0	0	No mechanism identified in generic interaction matrix
1,4	0	0	No mechanism identified in generic interaction matrix
1,5	0	0	Change in biodiversity is unlikely to be significant enough to cause any change in quality of life
1,6	0	0	No mechanism identified in generic interaction matrix
1,7	0	0	No mechanism identified in generic interaction matrix
1,8	0	0	No mechanism identified in generic interaction matrix
1,9	0	0	Change in amount of biodiversity is unlikely to be significant enough to need any increase protection of biodiversity
1,10	0	0	Change in amount of biodiversity is unlikely to be significant enough to need any increase protection of biodiversity
2,1	1	+1	Minor increase in biodiversity likely due to habitats created by new park within the development and soft-landscaped areas
2,2	n/a	n/a	Leading component – Natural environment
2,3	0	0	The proportion of the site allocated for the park is not large enough to effect the intensity of the development therefore this mechanism is not active
2,4	0	0	The proportion of the site allocated for the park is not large enough to effect the population density of the development therefore this mechanism is not active
2,5	1	+1	The creation of new public open space in the form of a park is likely to have a minor impact of the quality of life for site users and those in adjacent areas as it will improve the provision of green public spaces in the area
2,6	1	-1	The need to maintain the new park will require public funds and therefore will have a minor negative impact on Nottingham City Council's budget
2,7	0	0	No mechanism identified in generic interaction matrix
2,8	0	0	No mechanism identified in generic interaction matrix
2,9	0	0	The habitats created through the development are unlikely to be significant enough to require increased measures to them so this mechanism is not active
2,10	0	0	The habitats created through the development are unlikely to be significant enough to require increased measures to them so this mechanism is not active

3,1	0	0	As the site is currently has little biodiversity this mechanism is not active
3,2	1	+1	The creation of the park will provide new habitats but due to the size of the park this will only have a minor impact
3,3	n/a	n/a	Leading component – Built environment
3,4	1	+1	The provision of new dwellings will have
3,5	1	+1	High quality built environment and removal of tackle visual blight caused by the derelict site will contribute to improved quality of life
3,6	1	-1	Improvements to the public realm and new access roads will require public funds for maintenance and therefore will have a minor negative impact on Nottingham City Council's budget
3,7	0	0	No jobs will be creates so this mechanism is not active
3,8	0	0	No mechanism identified in generic interaction matrix
3,9	0	0	There will be no creation of or impact to buildings of conservation value so the mechanism is not active
3,10	0	0	There will be no creation of or impact to buildings of conservation value so the mechanism is not active
4,1	0	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
4,2	0	0	There will be no change of population density caused by the redevelopment so the mechanism is not active
4,3	1	+1	New home owners will contribute to the maintenance of the built environment
4,4	n/a	n/a	Leading component – Demographics
4,5	0	0	Changes in population density will not be significant enough to impact quality of life so this mechanism is not active
4,6	1	+1	
4,7	1	+1	Increased population will cause a minor increase in the market for goods and services in the area
4,8	0	0	No mechanism identified in generic interaction matrix
4,9	0	0	No mechanism identified in generic interaction matrix
4,10	0	0	No mechanism identified in generic interaction matrix
5,1	0	0	No mechanism identified in generic interaction matrix
5,2	0	0	No mechanism identified in generic interaction matrix
5,3	0	0	There will be no change in crime or anti-social behaviour caused by the redevelopment so the mechanism is not active
5,4	0	0	There will be no change in quality of life due to the redevelopment therefore this mechanism is not active
5,5	n/a	n/a	Leading component – Quality of Life
5,6	0	0	There will be no reduction in the number of people

			unemployment so this mechanism is not active
5,7	0	0	There will be no change in amount of free time caused by the redevelopment so the mechanism is not active
5,8	0	0	There will be no change in level of education caused by the redevelopment so the mechanism is not active
5,9	0	0	There will be no change in level of deprivation caused by the redevelopment so the mechanism is not active
5,10	0	0	There will be no change in level of deprivation caused by the redevelopment so the mechanism is not active
6,1	0	0	No mechanism identified in generic interaction matrix
6,2	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,3	0	0	There will be no change in public spending on the built environment caused by the redevelopment so the mechanism is not active
6,4	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,5	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,6	n/a	n/a	Leading component – Public economic
6,7	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,8	0	0	There will be no change in public spending caused by the redevelopment so the mechanism is not active
6,9	1	+1	Council tax from the new dwellings will provide a minor increase in Nottingham City Council's budget
6,10	0	0	Increase in income tax and business rates will cause an insignificant increase in funds for central institutional controls
7,1	0	0	No mechanism identified in generic interaction matrix
7,2	0	0	The increase in traffic will not be sufficient to cause increased air pollution so this mechanism is not active
7,3	0	0	Redevelopment is unlikely to effect the success of business significantly enough to alter the upkeep of public or semi-public spaces so this mechanism is not active
7,4	0	0	There will be no change in number of jobs so this mechanism is not active
7,5	0	0	There will be no new provision of goods or services so this mechanism is not active
7,6	0	0	There will be no increase in the number of businesses so this mechanism is not active
7,7	n/a	n/a	Leading component – Private economic
7,8	0	0	

7,9	0	0	There will be no change in manufacturing caused by the redevelopment so the mechanism is not active
7,10	0	0	No mechanism identified in generic interaction matrix
8,1	0	0	No mechanism identified in generic interaction matrix
8,2	0	0	There will be no change in incomes so this mechanism is not active
8,3	0	0	There will be no change in incomes so this mechanism is not active
8,4	0	0	There will be no change in incomes so this mechanism is not active
8,5	0	0	There will be no change in incomes so this mechanism is not active
8,6	0	0	There will be no change in incomes so this mechanism is not active
8,7	0	0	There will be no change in incomes so this mechanism is not active
8,8	n/a	n/a	Leading component – Individual economic
8,9	0	0	No mechanism identified in generic interaction matrix
8,10	0	0	No mechanism identified in generic interaction matrix
9,1	0	0	There will be no change in level of protection of biodiversity caused by the redevelopment so the mechanism is not active
9,2	0	0	There will be no change in level of protection of the natural environment caused by the redevelopment so the mechanism is not active
9,3	0	0	There will be no change in level of protection of the buildings of historical or cultural value caused by the redevelopment so the mechanism is not active
9,4	0	0	No mechanism identified in generic interaction matrix
9,5	0	0	No mechanism identified in generic interaction matrix
9,6	0	0	There will be no change in level of public intervention or protection of the natural environment caused by the redevelopment so the mechanism is not active
9,7	0	0	No mechanism identified in generic interaction matrix
9,8	0	0	No mechanism identified in generic interaction matrix
9,9	n/a	n/a	Leading component – Local / regional institutional controls
9,10	0	0	No mechanism identified in generic interaction matrix
10,1	0	0	There will be no change in level of protection of biodiversity caused by the redevelopment so the mechanism is not active
10,2	0	0	There will be no change in level of protection of the natural environment caused by the redevelopment so the mechanism is not active

10,3	0	0	There will be no change in level of protection of the buildings of historical or cultural value caused by the redevelopment so the mechanism is not active
10,4	0	0	No mechanism identified in generic interaction matrix
10,5	0	0	No mechanism identified in generic interaction matrix
10,6	0	0	There will be no change in level of public intervention or protection of the natural environment caused by the redevelopment so the mechanism is not active
10,7	0	0	No mechanism identified in generic interaction matrix
10,8	0	0	No mechanism identified in generic interaction matrix
10,9	0	0	There will be no change in level of protection at the National / E.U. level caused by the redevelopment so the mechanism is not active
10,10	n/a	n/a	Leading component – Central / E.U. institutional controls